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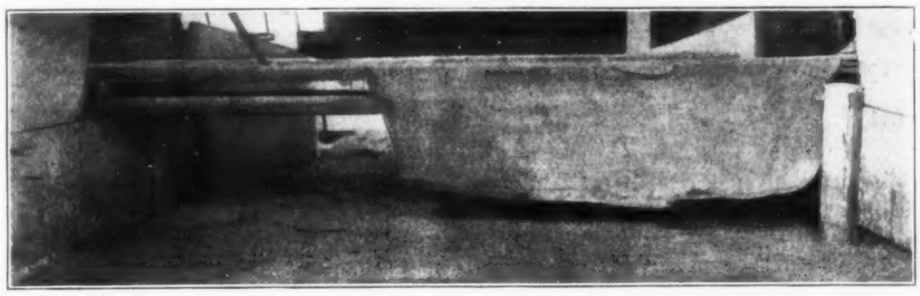
TURNING THE EGGS.

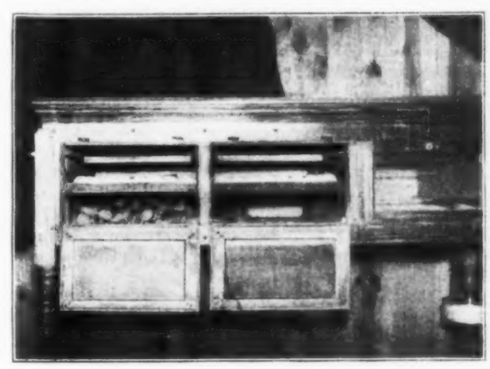


THE ARTIFICIAL MOTHER OR BROODER.

FEEDING SMALL DUCKS.

A RESERVATION OF BREEDING DUCKS.

A TRAY OF DUCK EGGS.



DUCKS HATCHING OUT IN INCUBATOR.

SHORE FRONT OF A DUCK RANCH.

DUCKS READY FOR MARKETING—TEN WEEKS OLD.

THE LONG ISLAND DUCK-RAISING INDUSTRY.

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DUCK RAISING AS AN INDUSTRY.

By HOWLAND GASPER.

AMONG the large and lucrative industries which have had their growth within the past score of years is the raising of Imperial Pekin ducks. Its inception and progress are alike interesting and instructive.

Eastport, situated on the south side of Long Island, may be considered the cradle of the business which has grown to such proportions, while William C. Pye, whose ranch in that village has during little more than a decade developed from a few scattered sheds to a magnificent ranch, embracing the most modern type of buildings and scientific equipment, was its pioneer.

POWER OYSTER-SHELL GRINDING MACHINE FOR DUCK FOOD.

Mr. Pye was a bayman when he conceived the idea of starting a duck ranch. Being without funds, he was obliged to secure credit for the lumber with which the first buildings were erected. His friends attempted to dissuade him from his object, but without avail. The resultant surprise of these friends may be therefore imagined when, at the end of the first season, his returns enabled him not only to pay all indebtedness, but afforded a substantial profit in addition. The capacity of the ranch was increased, a proportionate increase in profits being realized, and a few years later the output of one season exceeded 25,000 ducks. Mr. Pye's experience led many other parties to adopt the same occupation, and ranches of more or less pretentious dimensions arose throughout that section. Overproduction, as might be expected, was the result, and a number of ambitious raisers were practically ruined. The business was then, however, reduced to a substantial basis, and those now engaged in it are receiving an adequate profit.

The success of Mr. Pye and others who have achieved the most gratifying results has been due in no small measure to the kindly encouragement and able assistance afforded by their wives, who superintended all the more delicate details of the business.

On the duck ranches the most thorough system is maintained, an expert being assigned to each branch of the work, to which he devotes his exclusive attention. For example, one man assumes charge of the incubators, another of the breeders, while another attends to the mixing of the feed and its proper allotment to the various-sized ducklings. The requirements of these men are very exacting, both as to skill and time, and considerably higher wages are allowed them than for common laborers.

Attending the incubators constitutes one of the most important as well as interesting lines of work on a duck ranch, and the best experienced and trustworthy men employed are assigned to it. A lack of attention for only a few hours during variable weather, or neglect to properly refill or light the heating lamps, might prove disastrous and result in the loss of the whole season's profits. During extremely cold weather the attendant sleeps in the incubator house, where an alarm clock, set to ring at short intervals, enables him to properly maintain the uniform temperature in the machines.

The incubator house contains between a dozen and fifty machines, according to the capacity of the ranch. These usually contain 300 eggs apiece, 100 eggs being laid on a tray. These trays require turning at least twice a day, to prevent the germ touching any one portion of the shell too long a time. Trays containing water afford the necessary moisture, and prevent the egg becoming dry too rapidly. At the expiration o. four or five days the eggs are tested by a strong light, to determine the presence of a germ. Those appearing clear, thereby indicating infertility, are shipped to the city markets, and sold by unscrupulous dealers as fresh eggs. The only apparent difference between them and the fresh ones is noticed after breaking, when the tested egg's yolk will run. The test results usually in almost one-third of the original 300 being removed. About 150 of the remaining 200 will hatch, the proportion depending on the vitality of the germ. Many of the little ducklings, who do not possess sufficient strength to break the confines of their shell after protruding their bills, are assisted in this direction by the owner, who breaks it and draws the head out. Great care must be exercised against rupturing a tiny blood vessel, which would invariably produce death. The incubation of a duck requires twenty-eight days, just one week more than a chicken. The little ducklings are allowed to remain in the incubator several hours to dry before removal to the brooder house. A temperature of between 101 and 103 degrees is maintained during the process of incubation, being slightly higher at the last stage of hatching than during the first few days.

The brooder houses are divided into sections, each one of which holds between 25 and 200 ducks, according to their size. Hot-water pipes run the entire length of the building, being raised a few inches from the ground and covered by boards to radiate the heat below. During the night the ducks roost beneath them, where the temperature of the air is considerably higher than outside.

Feed in the form of a mixture of corn meal, bran, wheat middlings, and meat scrap is fed, and while as large a quantity as will be eaten is furnished, none is allowed to remain in the pens. Fish, when obtainable, is introduced into the feed, and greatly accelerates the growth of the stock. Owing to its tendency to impart a strong flavor to the flesh, it is withdrawn after the first month. Fattened by this diet the ducklings grow rapidly, and in a few weeks will weigh more than six pounds, when they are considered marketable. A selection of the most robust and healthy is made to be used for breeders another year, the others being picked and packed in ice for freightage to the city. The picking is accomplished by girls, who receive five cents for each duck. While inexperienced hands are satisfied to earn one dollar a day, those who have gained strength and expertness not infrequently pick forty and fifty ducks at a single sitting. Thousands of dollars are distributed every season among the young women of the village where duck ranches thrive, the money in many instances contributing materially to the family support.

The picking of the ducks is a most disagreeable task. It is necessary to rise at 3 or 4 o'clock in the morning to prepare the ducks in time for the afternoon express. Then the nauseating odors are extremely repellent to uninured olfactory nerves, while the uproarious quacking of the ducks is almost distracting. One of the most objectionable features, however, connected with the work is the soaking through one's clothes of water from the ducks.

When the industry was new, keen rivalry existed among the raisers in the endeavor to supply the first of the season's ducks to the market, as high as sixty cents a pound being then received for early shipments. The transferring of ducks to cold storage in latter years, however, has practically ruined the profits from this source. The middle of April generally marks the first shipment of ducks to the city markets.

Each successive year witnesses an increasing deterioration in the Pekin ducks as respects fecundity, a condition due probably to the interbreeding of the birds. Practically all the Pekin ducks in the East were obtained from the same original breeders, and to introduce new strains it will be necessary to import fresh stock from China, the home of the variety. This deterioration, as well as the decline in spring prices for ducks, may account for the smaller profits being realized by the raisers.

The profits on a duck ranch depend in no small measure upon the character of the breeders, which are the choicest birds obtainable. About 200 of these are kept in an ordinary-sized ranch. One drake is allotted to every six or eight ducks. During the season each duck will average 100 eggs, their timeliness, fertility, and vitality being more important than the quantity.

SELECTING DUCKS FOR THE MARKET.

There is, perhaps, no feature of the business more interesting and replete with suggestive instruction than that representing the young duck through its various stages of development. The fresh egg exhibits the future duck as a little germ spot, no larger than a wheat grain, which does not acquire the power of receiving nourishment with the mouth, or breathing atmospheric air, until a considerable period has elapsed. The little germ spot may be most satisfactorily watched by removing a fragment of the upper portion of the shell, when the germ will appear directly under the aperture. The development of the duckling renders the manipulation easier; a few hours of warmth produces the first idea of a duck, which assumes the form of a little whitish streak lying across the egg and less than a tenth of an inch in length. During the course of 24 hours the germ assumes a curved shape, resembling a maggot in its general size and appearance. The second day shows the heart, while on the third the blood vessels appear for the first time. The developing process proceeds until perfect bodily structure is attained, the feathers appearing about the twentieth day. A week later the little fellow may be heard quacking through the larger end of the egg, which it has pierced with its bill. Nourishment during confinement in the shell is received from the yolk through the abdomen. The duck picks the shell in a circle, which is supposed to correspond with the cause of the air vesicle and emerges as it were from the trap door thereby produced.

The illustrations on the front page, made from photographs, show at the bottom a general view of the shore front of a duck ranch and a pen containing a group of ducks of the right size for marketing. The center illustrations show another pen, where breeding ducks are kept, a young man conveying a tray of ducks' eggs to one incubator, and an incubator illustrating the hatching of young ducks. They break through the eggshell on the upper tray, and drop through the netting to the compartment underneath, where they are observed huddled together.

The upper views show the method of turning the

YOUNG DUCKLINGS HATCHED OUT BY CHICKENS.

FLOCK OF HALF-GROWN DUCKS.

THE LONG ISLAND DUCK-RAISING INDUSTRY.

eggs in the tray, an artificial mother or brooder consisting of a heavy cloth or burlap depending nearly to the ground in front of steam pipes located at the top. The cloth retains the heat from the pipes, yet allows the young ducklings to run out to the open space beyond. The other picture shows the number of ducks in a yard being fed.

The views on page 24256 illustrate a chicken house where setting hens hatch out ducks' eggs, and a flock of half-grown ducks swimming around in a confined wire work pen, also the workman selecting the best ducks for the market, and another killing the ducks after selection. The legs are tied together, then a weight is attached to a string, which is fastened around the base of the upper bill, then with a knife the throat is cut. The weight prevents the head from flying around. When dead, the ducks are laid in groups on their backs one over the other, for feather picking, as shown in a small illustration.

It is necessary that the breeding ducks be well fed with lime-producing material for eggshells, so a power oyster-shell grinder is kept continually in use. Where oyster shells are not abundant, some qualities of crushed limestone are used as a substitute.

NAPHTHALENE AS A MOTOR FUEL.

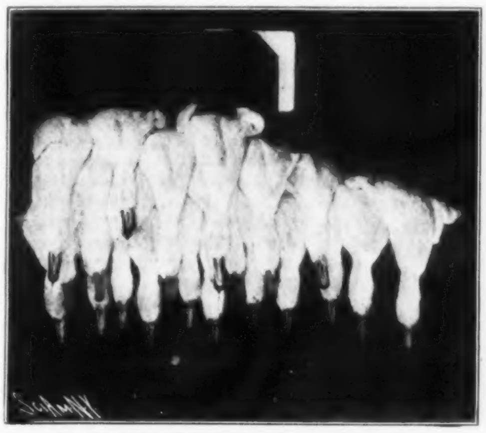
While gasoline is open to many objections, particularly the great fire risks involved in its use, due to its great inflammability, so far no fuel has been found which can compare with it in every respect. At first much was expected of denaturated alcohol, the vapors of which are less inflammable than those of gasoline. Besides, as alcohol is soluble in water, and does not float on it, an alcohol fire may be extinguished by means of water. Heavy petroleum oil has also been used to some extent, and recent experiments with a Peugeot car show that the use of naphthalene has been considered.

Far be it from us to discourage those who seek to employ this fuel, or rather to adapt it to existing motors; but we believe that they are making a mistake, the same as those who attempted to substitute pure alcohol or alcohol mixtures for gasoline in explosion motors without making any modifications in these motors, and who concluded from their failure that alcohol and alcohol mixtures are not adapted for use as motor fuels.

Naphthalene is a solid hydrocarbon which can be purchased at a low price, because it is a by-product in a number of manufacturing processes, being produced in gas works, petroleum and shale oil refineries, etc. The only use to which it is put at present, after some few trials in the dyeing industries, is to keep moths out of our clothes (as moth balls). The choice is therefore judicious, but it appears that all these experiments have been abandoned. Let us see what may be the reason for this.

The first attempt at utilizing this product was made by gas engineers, it being found that gas tubes were frequently obstructed in winter by deposits of crystallization of naphthalene. This crystallization of naphthalene decarburized the gas, and consequently diminished its illuminating power, which was particularly noticeable because incandescent gas lights were not known at that time. It was therefore proposed to place the naphthalene in a small boiler close to and heated by the gas flame, so that the gas was recarburized before burning. The idea would have been not at all bad if, on extinguishing the flame, the naphthalene had not frequently clogged the openings in the burner tip, and it was necessary to open the tip before the burner could be lighted again. When incandescent gas lights came into use this system was entirely abandoned.

Later on, naphthalene was proposed for use in whitening the flame of kerosene lamps and for carburizing alcohol for illuminating purposes. Naphthalene is only sparely soluble in alcohol, alcohol at 95 deg. dissolving only 4 to 5 per cent of its weight of the substance. But this small quantity communicates to the alcohol a very peculiar property, that of dissolving a very large proportion of kerosene oil (25 to 50 per cent in volume, according to the origin of the oil), particularly the heavy oils of Russia and Roumania. It is this property which several years ago permitted to obtain carbureted alcohol of a calorific power almost



DUCKS PREPARED FOR FEATHER PICKING.

as high as that of gasoline. Unfortunately, a very small quantity of water, even the humidity of the air, disturbs these rather unstable mixtures by reducing the degree of the alcohol. That difficulty could have been overcome, however, with some care, and would not have prevented the use of the mixture for lighting, as well as for motor purposes, if the naphthalene had not also communicated another very serious defect in all these liquids.

Naphthalene, although volatile, is a solid very readily sublimable; that is to say, it will condense into the solid state on the least lowering of temperature much more readily than the liquids (gasoline and alcohol) in which it is dissolved. Consequently the least stoppage causes the wicks of the lamps to harden, and the orifices of the carbureter to clog, and a careful cleaning becomes necessary before the burning process can be continued. This trouble is constantly to be expected in the use of this combustible, either alone or in solution, in motors as at present constructed, and it is inadvisable to seek to solve the problem in this direction.

To arrive at a satisfactory solution it is necessary to start with the most advantageous combustible or combustible mixture, according to the country and the conditions under which the motor is to operate, then study the motor for the best utilization of the fuel decided upon. Only under these conditions are there any chances of arriving at the solution insuring the greatest economy for each particular case.—La France Automobile.

HOW LONG DO MICROBES LIVE?

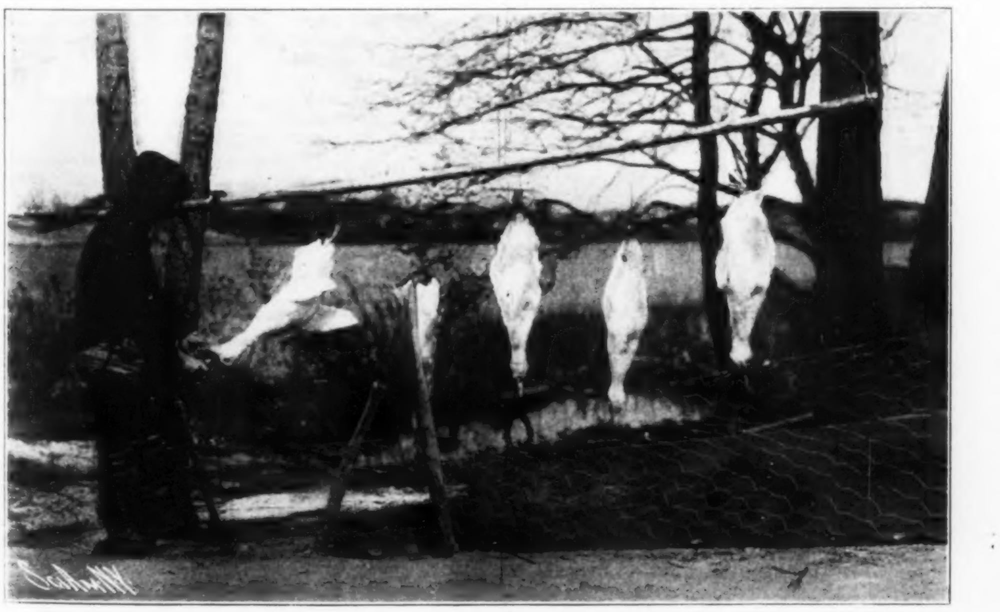
What is the length of life of a disease germ? Many experiments under all sorts of conditions have been made to discover an answer to this question. Bombibbi observed that the bacillus of tetanus resists putrefactive processes for a great time, and that the power of resistance is greater when the temperature is rather high and lower when this temperature decreases. Arloing, Cornevin, and Thomas, according to Public Opinion in an article abstracted from an Italian scientific contemporary, observed that the virus of the carbuncle, after being desiccated, conserved its virus for a very long time, while the great resistance of the various pathogenic germs of the earth has been demonstrated by many authors. The resistance of pathogenic microbes in water was demonstrated by Schwartz, while Sanfelice studied this resistance in putrefactive infusions of vegetable and animal matter, the microbes in these cases resisting for five, ten, and fifteen days either at the temperature of the surrounding air or in a stove at 37 deg. C.

Turco was able to recover the bacillus of tetanus from a piece of wood taken from the point of inoculation in an animal many months after the death of the animal, and he states that the bacillus of tetanus resists putrefactive processes for eighty days and desiccation thirteen. Loesener studied the resistance of certain germs in buried corpses and was able to isolate the bacillus of tetanus in all of its virulence after 334 days of inhumation, while Mattei states that the virus of the carbuncle in one case was conserved in the infected material for a space of ten years. Henjean was able to produce a similar result, that is, to bring forth on a splinter of wood the tetanus bacillus taken from the body of a person who died of tetanus ten years before, while Tizzoni and Cattani demonstrated experimentally that the spores of tetanus resisted the action of dry heat to a temperature of 150 deg. C., and resisted for two minutes steam at a temperature of 100 deg. In describing his work, the Italian author states:

"I decided to make a series of experiments myself, limiting my observations, however, to the bacilli of malignant tumor, the carbuncle, and tetanus. I found that the bacilli of malignant tumor placed in a carefully closed bottle with a gum plug—the bottle containing sterilized water and a pure culture of malignant tumor bacilli—kept their full force for a period of ten years. Another bottle containing sterilized water, but only a small quantity of malignant solution, and with a stopper of cork, also gave positive results after ten years. This was also true of a bottle closed with a cork stopper and containing a cold solution of meat which maintained its full powers for ten years, while the same result was obtained with bottles containing sterilized earth infected with the tumor bacilli, an infusion of vegetables, and in other varieties of experiment.

"In the case of the carbuncle microbe a bottle containing water, not sterilized, after a period of ten years, gave no evidences of virulence, the results obtained being negative. In the case of sterilized water the carbuncle microbe, after ten years, did not produce its virulent effects, which was also true of earth moistened with water and infected with the carbuncle microbe. In the case of this microbe negative results were obtained for dry earth not sterilized, for a cold infusion of meat, infusion of vegetables, etc. In the case of tetanus I found full virulence after ten years for sterilized water, for non-sterilized water, infusions of vegetables and earth, infusions of earth and meat, bottles containing dry earth, moist earth, etc. From these facts I concluded that the spores of tetanus and malignant tumor may resist either desiccation in the earth, destruction in sterilized water, in infusions of vegetables and meat, etc., for a period of ten years; that the resistance of the microbe to tetanus is greater than that of malignant tumor; and that the virus of the carbuncle after a period of ten years is generally destroyed."

A paper read recently by Mr. Emile Demenge before the Iron and Steel Institute discussed the utilization of exhaust steam from engines acting intermittently, by means of regenerative steam accumulators and of low pressure turbines on the Rateau system. The speaker said that the economy resulting from the application of the Rateau system can be ranged under two heads. 1. Saving in the Cost of Installation.—If the cost of a turbo-electric plant with accumulator be compared with that of an electric plant with a piston engine and boilers, there is a marked saving in favor of the former. The difference arises from the substitution of a regenerative accumulator for the other sources of steam supply, which are much more costly, and also from the much lower first cost, and cost of laying down of the electro-turbine as compared with cost of dynamos and piston engines capable of developing the same power. It is natural that the relative importance of these various elements should vary according to the additional power required, the weight of the accumulator, or the conditions under which the prime motor works, and of the general method of exploitation. The great variations in the cost of engines are also an important obstacle in the way of giving exact figures. It follows, however, from the comparative estimates made between the different combinations intended to produce a certain power by the method of the accumulator and turbine, and again by piston motors with the ordinary generator, that the economy of setting up the plant by the Rateau system is always very marked, and may, in the case of attaining 500 horse-power, for example, reach \$8,000 to \$10,000. Furthermore, it is well to note, that when a central condenser exists, it can be utilized for the low-pressure turbine, while an electric unit driven by live steam needs, as a rule, a special condenser. 2. Saving in Cost of Working.—This item is obtained by the reduction of the number of men employed at boilers; by the lowering of the amounts to be set aside for redemption; cost of installation and interest on capital; and, in particular, by the diminished consumption of fuel.



METHOD OF KILLING DUCKS.

THE LONG ISLAND DUCK-RAISING INDUSTRY.

THE TEN TEMPLES OF ABYDOS.*

By Prof. W. M. Flinders Petrie.

For the first time, the whole history of one of the great national sites of Egypt has been opened before us; dating from the beginning of the kingdom, and ending with almost the last of its native kings—from Mena, about 4700 B. C., to Nekht-hor-heb, 370 B. C. History is here laid out before us in strata, from which the past can be read as we lift them away one from another.

In order to read, however, one must know the alphabet of the subject; and that has only lately been learned, from the pottery, the flints, the beads, which show, each, the age to which they belong. Excavation on a site with a long history is mere destruction if each stratum is not read and interpreted intelligibly as it is opened; unfortunately, this has never been done before on any such site. On the earliest sacred site of Abydos, the first capital of Egypt, temples had been piled one on the ruins of another, until ten ages of building stood stacked together in about twenty feet depth of ruins. Each temple had become partly ruined after a few centuries, and then at last was pulled down, leaving a foot or two of the walls and foundations; and a new temple of a different plan was then erected on the ground. America is not old enough for this to be done even once; but London stands on a mound of over twenty feet of ruins, from which its past will some day be read as we now read that of Egypt.

The earlier temples were all of mud brick. Stone first appears for the doorways of the fourth temple, that of the sixth dynasty, about 3400 B. C. Sculptured stone walls are found of the eleventh dynasty; and walls were wholly of stone in the twelfth dynasty, about 2700 B. C., and in the later temples. These buildings of the well-known historic times are, however, of much less importance to us than the earlier temples, which yield us fresh views of the civilization to which they belong.

About the middle of the second dynasty, say, 4300 B. C., a clearance of the temple offering was made, and hundreds of small objects more or less injured were thrown into a disused chamber, which served as a rubbish hole and was later buried under fifteen feet of ruins. The contents of this chamber were old and disregarded at that time; and as the first king has been found close by at the same level, it seems that we should refer the contents of this limbo to the first dynasty.

Groping in the thick brown organic mud of this rubbish hole, I lifted out one by one the priceless examples of glazed work and ivory of this earliest age of great art—an art of which we had never understood the excellence from the traces hitherto known. The ivory was sadly rotted, and could scarcely be lifted without dropping asunder in flakes. So when I found that I had touched a piece, it was left, until at last a patch of ground was left where several pieces of ivory had been observed. Cutting deep around this, I detached the whole block of sixty or eighty pounds of earth, and had it removed on a tray to my storeroom. There it dried gradually for two or three weeks; and then with a camel's-hair paint-brush I began to gently dissect it and trace the ivory figures. Not a single piece was broken or spoiled by thus working it out, and noble figures of lions, a bear, a large ape, and several boys came gradually to light. Suddenly a patterned robe and then a marvelous face appeared in the dust, and there came forth from his six-thousand-year sleep one of the finest portrait figures that has ever been seen. A single photograph can give but little idea of the subtlety of the face and the expression, which changes with every fresh light in which it is seen.

Wearing the crown of Upper Egypt and clad in his thick embroidered robe, this old king, wily yet feeble with the weight of years, stands for the diplomacy and statecraft of the oldest civilized kingdom that we know. No later artist of Egypt, no Roman portrait-maker, no Renaissance Italian, has outdone the truth and expression of this oldest royal portrait, coming from the first dynasty of Egypt. The simplicity and lack of pretension are almost baffling; it does not claim any idealism or beauty, it scarcely seems to intend to be so fine or powerful, and yet it appeals equally to the first artists and to the ordinary man. No other object has so generally compelled the admiration of visitors in any of our annual exhibitions.

That this did not stand alone as a stray phenomenon is seen by the group of other ivories, of which we may instance a very small one of a woman, which shows the same character of work in simplicity and directness, and in the perfectly natural expression of the statuettes. Among other figures discovered, those of boys, standing, walking, and seated, are all true and unconventional in form, and show firm and accurate modeling. A little bear seated on the ground and couchant lions and a mastiff show that animals were studied and understood as well as men. We must now grant in future that a complete art had arisen nearly seven thousand years ago, and that it has seldom been equaled and hardly ever surpassed in the five fresh births of art which have occupied the course of human history.

Nor was the skill of technical work neglected. The abundance of vases and bowls, cut from the hardest and most refractory materials—granite, syenite, porphyry, rock-crystal, and obsidian—which we found in the royal tombs of this age, show a taste and ability for fine material and work which was never equaled in later times. And the mastery of glazing provided large vases with the royal name inlaid. This was part of a globular vase, eight inches wide, of green glaze, with the royal hawk name inlaid with purple glaze. Here we have the property of the oldest king in the world whose name is preserved by history—M-na, the first king of the first dynasty of Egypt. This vase must have been handled by this figurehead of all monarchy, and almost certainly was dedicated by him in the primitive temple of the capital.

Strange, indeed, it is to look on so personal a link, and to think that the whole sum of what we know as human experience has come and gone since this was last worthily handled; the pyramids, Thothmes, Rameses, the Greek, the Roman, the Northman, all were unthought of when this last saw the light.

The use of colored glazes was also carried out on a great scale for wall decoration. Thick tiles, a foot high and half as wide, were made, fully glazed in green on both sides, and provided with a deep keying on the back, and grooves to hold thick copper wires to thread them together, so that one could not be lifted without moving those on either side. The surface was ribbed to represent papyrus stems; and there was a band of tiles of papyrus heads along the top of the stem tiles. This glazed tiling was also made in a great variety of sizes and patterns—some ribbed, some fluted, some plain, some inlaid with inscriptions, and others copied from matwork design. Another light on the architecture is given by the glazed vases copied from the lotus capitals, showing that such a form was already in use. The complete capital is of green glaze with purple spots, the same polychrome as the Mena vase, and probably from the same factory. The form of the top, with a slightly raised disk, is evidently copied from the architectural detail of a capital. The other work in glazed pottery is of great variety. Figures of men, women and children, captives and servants; figures of baboons innumerable, of various quadrupeds and birds; model vases and shrines; toggles for fastening the dress, and beads of many forms—all subjects came alike to the ready hand of this early potter. He modeled the forms in the siliceous paste, and then covered them with the hard coat of glaze which binds the material firmly together, and which has in many pieces even kept its color after thousands of years in wet ground.

An entirely new class of glaze work is the tile with relief designs and inscriptions. One whole tile I picked out of the mud, which has a figure of an aboriginal negro chief, and his name and locality. This proves of particular interest, as he belonged to the "fortress of the Anu," a people with whom the early Egyptians were continually at war, and the day of whose destruction was a yearly festival down to late times. From this tile we now know that the Anu were the negro races of the southern border, which the Egyptians had such difficulty in holding back. The Sudan question is as old as the beginning of history.

In another chamber we found a large number of sacred figures, which had been carefully put away when thought too rude for the devotions of more civilized times. Few, if any, were as late in style as those which I had taken out of the mud in the great rubbish-pit; and judging from that, and their resemblance to figures found some years ago at Hierakonpolis, it is probable that these are as early or earlier than the age of Mena, and so touch the close of the prehistoric time. The most curious, and probably the oldest, objects here were some very elementary figures of baboons, and other purely natural stones. The figures of baboons are very slightly worked. Rude lumps of limestone had been picked up, having a slight resemblance to the form of the animal; and then a little pounding away of the surface had improved them into an unmistakable connection, helped in some cases by a few scores scraped with a flint. The first of these is only pounded, like an Easter Island idol; the second is the most improved, by scratching a mouth and eyes; the third and fifth have only a broad groove hammered to divide the head from the body and mark the snout. And we see in the fourth a natural flint selected for its resemblance to the baboon, and slightly improved by knocking off a few awkward projections; there can be no question as to the intention of placing this flint with the other elementary figures; they were all alike kept in honor of the sacred cynocephalus baboon. But with these figures, which are seven or eight inches high, there were two much larger flints, two or three feet high. They were set upright in the chamber, and had evidently been selected, out on the desert, a mile or more away, and brought into the temple, associated with the very primitive baboon figures, and placed on end with them. All this attention to them is only explained by looking at their resemblance to animal forms. In the first one we see a quadruped on its hind legs, the head having been lost at the break on the top. In the second stone there is the baboon form tolerably evident.

We cannot but see here the primitive fetish stones, such as the Papuan will now collect and reverence. Thus we touch the Egyptian behind all art and civilization, back in the time when the stray resemblances of nature caught the attention of the mind as yet untrained to disentangle the connections of things. That mind is by no means now extinct; the coat of arms of cardinals are quoted in telegrams as forecasts of their probable papacy, in accord with a supposed prophecy, and the name of a ship is supposed to link its fate with that of its namesake. Most men pick up their fetish stones by the wayside in life, and imagine connections which strike their fancy.

But these stones, found far below the polished statues of an Egyptian temple, open our eyes to the source of sculpture. We see here that man did not first sit down with a block of stone and determine to carve some figure, but he picked up some strange, weird form that seemed as if it must be something else than all the rest of the stones around; he treasured it, venerated it, improved it so as to piously help nature; and little by little he became bolder, until the finished statue did not even need the least resemblance of the block to start with. I envy the glow of the first man who saw that any stone would do, and that he need not be the servant of nature and only adopt what was indicated to him. Such are the glimpses of the rise of art which these stones give us; but these were by no means the earliest examples of such notions, as prehistoric man in Egypt had long existed, though here we touch a survival of the primitive ideas in these rude untouched fetish stones set up in the first temple of Abydos.

In the same chamber with these early sculptures we found also a modeled pottery head of a camel. So far this animal was unknown in early times in Egypt. Not a single figure of or allusion to the camel is found there before Greek times, although familiar in Syria from the days of Abraham. Here we find that at least in the first dynasty the camel was known to the Egyptians.

A similar throw-back in history occurs when we find a piece of iron in a bundle of copper tools of the sixth dynasty, or about 3400 B. C. Hitherto not a scrap of iron had been found which could be certainly dated before 1000 B. C. in Egypt, and it was not in familiar use till Greek times. But we see now that in some way the Egyptians got a bit of iron, apparently only worked into a wedge, two or three thousand years earlier.

It is not only the history of Egypt that we recover deep down in its ruins, but also that of Europe. Some years ago I found foreign pottery in the prehistoric time, and the earliest stage of painted Greek pottery in the royal tombs of the first dynasty. Now, of the same age, we find in the temple a whole class of black pottery which is not Egyptian and is clearly Greek in its forms. I took a piece of it in my pocket to Crete; and there, on the terrace of Dr. Evans' house at Knossos, I picked up the exact parallel to it, undistinguishable in color, material, and polish. Unfortunately the Cretan pieces are much broken, and the forms have not been yet restored for comparison with the amphora and bottle which I found; but more than a dozen black bowls from the temple are like those of Crete. As to the age, this pottery belongs to the late neolithic period in Crete, which must be of 4000 B. C., or earlier, in good accord with the Egyptian date of about 4500 B. C. for this class of pottery. It is only by thus connecting the early dawn of Europe with the more complete history of Egypt that we can recover more of our own past, and trace surely the various steps by which our present civilization has been built up. To understand the action of the present time, to grasp the meaning of the tendencies of its religion, its politics, and its life, without knowing the stages by which it has grown, is as ineffective as to look at geography without the geology which has determined it and which controls it. Just as the strata below preserve the geography of the past, and have formed and will yet regulate in future the surroundings of mankind, so the past civilizations have formed the social present, and will yet control the future of man.

We come down now from this beginning of the high civilization, which is only now brought before us, and some eight centuries later we meet, at 4000 B. C., a name which has never fallen into oblivion, but has kept its place as that of one of the leading figures of history. By the pen of Herodotus the personality of Cheops has passed over from the wreck of Egyptian literature, safe and sound into the Greek world, and so to our days. The character of this great and masterful ruler is the oldest that has been handed down in the memory of every generation since his time. In all ages to offend a priesthood is a sure title to infamy; and whether it be Cheops or Manasseh, Leo the Iconoclast or Henry II., the result is the same. In this light must we read the history of Cheops, who is said to have "abandoned himself to every kind of depravity. He closed all the temples, forbade the Egyptians to offer sacrifices, and ordered them all to work for himself," as Herodotus records. Manetho likewise says that "he was supercilious to the gods," but adds, strangely, that he "wrote the sacred book which is greatly valued by the Egyptians." This apparent contradiction shows how we are to read the abuse which precedes it. Of the depravity there is no evidence beyond a confiscation of religious endowments; of his real religion there is the proof that he edited or wrote a work which was valued in ages afterward, and the temples of Bubastis, of Koptos, and of Denderah, all show him as a religious founder. Hitherto we have had no portrait to enable us to judge the man as an acquaintance, to estimate his abilities, his ideas, and his nature; and he has remained an enigma which no historian has fully understood.

At last we can look into his character face to face. In one of the storerooms of the temple of Abydos many figures had been thrown aside, probably in the sixth dynasty. Those of wood had entirely decayed, and mere films of painted stucco were left in the earth; but one little figure of ivory about three inches high had preserved its original polish almost complete. The workmen in digging had broken the head off, and brought me the figure headless. When I cleaned it, and found the Horus name of Cheops (Khufu) upon the throne, it was evident that no trouble was too great to recover the head—the only portrait of one of the greatest kings. I anxiously inquired of all the

* The Egyptian Gazette.

boys where they had thrown the earth, and marked out the possible limits of our search; and then began a sifting of every morsel, in order to find a piece no bigger than the tip of the little finger. A whole day the boys sifted, and day after day they went on sifting a great bank of earth; one week passed, and then another; but at the end of the third week of incessant sifting the precious face was found in perfect state, and the next day the back of the head completed the figure, and Khufu once more sat in all his dignity before us.

We can now study the nature of this great monarch. The first thing that strikes us is the enormous driving-power of the man, the ruling nature which it seems impossible to resist, the determination which is above all constraint and all opposition. As far as force of will goes, the strongest characters in history would look pliable in this presence. When we analyze it we see the ideality of the upper part of the face—the far look in the eyes, and the high cheek-bone; the expression of conception and construction and the attaining of great ends. And when we look below, to the mouth and jaw, we feel the terrific force which carried forward his ideals, the all-compelling power to which no man could say nay. There is no face quite parallel to this in all the portraits we know—Egyptian, Greek, Roman or modern.

Face to face with Khufu we can better understand the record that we have of his acts. No doubt such a man, with great ideals and unlimited strength of will, did many unpleasant things; but the sight of such a face wipes away any such notion of personal baseness or evil nature. And this reform and economic revolution was the step toward the resumption of the wealth of the country by the state. The king was all in all to the Egyptians—lawgiver, administrator, organizer, general, high priest; and after putting an end to the wasteful service of the religion, "he made them all work for himself." The name of Khufu still remains at some of the great temples, at a vast quarry of alabaster, on the rocks of Sinai, and above all at the Great Pyramid of Ghizeh, which is the greatest mass of masonry and contains some of the most accurate work that has ever been put together by mortal man. Such were the triumphant results of this ruling will, of which we now see the living expression set before us.

The accounts of the reign of Khufu have been slighted by some writers as improbable. But this year an entire confirmation was found in excavating the temples at Abydos. At the bottom of all was a temple of the first dynasty; above that another temple of the second dynasty; and then at the fourth dynasty there was a blank in the ruins, with no great walls or building, but only a hearth of vegetable ashes, among which were hundreds of little pottery offerings, without a single bone of a sacrifice. Here we actually saw before us the abolition of the temple and the sacrifices, and the substitution of the clay models of no value, in place of the costly offerings which had sustained the priesthood. After that the system of temples revived, and increased in cost and grandeur to the end of the history. But the political economy of Khufu stood revealed, and Herodotus was vindicated.

Rows of pits are sunk, and the earth thrown out, until buildings are reached, and then each wall is followed and traced, and one structure below another is cleared, until all the past history of the series of temples is exposed, and every fragment has been transferred to the plans which permanently secure the facts.

More than four thousand measurements and a thousand levels were taken to unravel the history of these temples of Abydos; and every day I was cutting sections of the earth with trowel and knife to trace in the mud soil the course of the mud-brick walls. The pillager merely in search of antiquities would find only two or three dozen inscribed stones and much worthless pottery; but for the historian and archæologist there was the history of the land for four thousand years in that twenty feet of ruins. I have to thank England and America equally for enabling these discoveries to be carried on by means of the Egyptian Exploration Fund, in the publication of which the detailed results are given.

THE SPIDER.

By John A. Morris.

One of the most interesting and useful studies in natural history is to investigate the ways of the indefatigable and persevering spider. In the first place the spider is not an insect, as many people believe, and only resembles an insect in that both are annulates. The spider has eight legs while the insect has only six. The nervous system is of an entirely different character, and the circulatory and respiratory systems are built on different lines from those of the insect. Insects have many compound eyes while the spider has only eight, and these of a simple kind. The spider has no separate head, the head and thorax being joined together; neither does the spider pass through a series of developments called "transformations," but when the young spider is hatched it is a spider and retains the same shape throughout the whole of its life. Again, no insect at present known can spin silken threads; and in this the spider is very proficient. Moreover, the spider can produce different kinds of silks, according to the object for which needed. The diadem spider makes a web of radiating cables, like the spokes of a wheel, and with a slight thread wound spirally over the spokes. There are cables like these suspending the whole web, and guy ropes of similar construction support it on every side. Now a fly may come along, and hitting the cable falls into the net where it becomes meat for the industrious spider. To examine the web with a powerful magnifying glass we will see the smoothness of the cables and spokes, while the spiral thread is somewhat gummy through the stickiness of the little globules covering the thread. In an inch of thread there are 14,000 of these globules, and it is reckoned that an average web will contain not less than 87,000 of them. These globules are like bird-lime, and the moment an insect touches one of them with its leg or wing, it is held tightly by the gum.

Some of these spiders are very crafty in catching their prey, being able to imitate stamens of flowers in order to catch butterflies. There they stand by the hour with their yellow forelegs stuck up stiff in the air. A butterfly comes along and dips into the flower to suck honey; and that is the end of him. So real is this appearance that even botanists of keen vision and clear sight are often deceived. Orb-weavers scatter rubbish in their webs till they look like old things that have been up two or three months, and then hide themselves among the chips and pieces of bark that they themselves have placed there. One kind of spider has a trick of spinning a little round patch of white silk on a leaf and sitting in the center, where unobserved, it waits and watches for whatever comes along. The outer edge of the spider's body is of light, grayish green merging into white with a dark spot in the center thereof. An entomologist of an investigating turn of mind was once desirous of knowing why butterflies were attracted to birds' droppings. He tried to pull one away from it; and found as the poor, miserable, caught butterfly did, that he could not readily get himself loose because the spider had hold of the other end and was busy giving himself a feast of blood. Some spiders not only look like withered flowers lying on the ground, but have developed a perfume like jasmine. Other spiders are able to make themselves appear like snail shells.

To learn the aeronautic intelligence of the spider, conduct an experiment of this character: Anchor a pole in a body of water, leaving a few feet of the pole above the surface, and put a spider upon it. Watch operations, and you will see him spin a web several inches long, hang to one end while the other blows off into space, in the hope that some object may be struck whereby he may gain his freedom. This plan proving a failure, he patiently waits until the wind changes, and then sends another silken bridge floating off in another direction. Failure after failure may be had, but our spider still keeps on until all points of the compass have been tried, when he proceeds to work along different lines. He climbs to the top of the pole, and begins to build a silken balloon, and although possessing no hot air with which to inflate it, he is able to make it buoyant. After finishing the balloon he fastens it to a guy rope, the other end of which he attaches to the island pole from which he wishes to escape. He then gets into his aerial vehicle and makes it fast, while he proceeds to test it to see whether it is capable of bearing him away. If it is not, and he is dissatisfied with it on account of its being too small, he will tear it down, take it apart and construct another on a larger and better scale. Sometimes a spider has been seen to make three or four different balloons before he was satisfied with his experiment. Then he will get in, snap his guy-rope, and sail away to land and freedom as independently as you please.

The water-spider may not inappropriately be known as "the spider with the diving-bell." In the construction of her diving-bell nest the spider constructs a thoroughly workmanlike apparatus without nearly as much fuss as man makes when he wants a diving-bell. She simply plunges into the water, and walks down the stem of a pond reed to select a suitable position for her silken palace, which when found a number of strong lines are fixed in all directions for anchorage. In the midst of these she proceeds to construct a web, in the shape of a thimble, but not quite so large. This is full of water, which is replaced with air carried in the body of the spider from the surface of the water. One naturalist conducting a series of experiments along these lines tells of the matter in these words:

"Her body and legs are covered with grayish hairs. When I touch her she plunges quickly into the water. The movement is so quick that the air has not time to escape from her hairy coat, and she goes down surrounded by a globule of air. When across the threshold of her own home, she carefully dislodges this air by rubbing herself with her legs. The liberated bubble immediately rises to the roof of her house, and there remains. In this way she at length fills the whole bell, and takes up her position in it, always head downward. Here she passes the winter, keeping snug and quiet until the warm days of spring invite her to the surface in quest of flies and other small insects. About this time the spider comes to inspect the house, and finding it hardly large enough for two, they bring down more air, which expands the elastic walls, and gives the requisite space.

"Soon the lady of the house constructs a neat and comfortable little cocoon, which she fixes in the roof of her nest, and deposits about one hundred eggs in it. In due time they hatch, and the swarm of tiny spiders make themselves happy, until each is large enough to set up a separate establishment."

Dr. H. C. McCook, the eminent naturalist, thinks that the mode of the orb-weaving spiders in constructing webs is laid through the help of a current of air carrying the thread. In a number of cases Dr. McCook observed the spiders passing from point to point by means of lines emitted from their spinnerets and entangled upon adjacent foliage. These mimic "wire bridges" were often of different lengths, owing to the direction of the wind and the fixed objects about it. Lines of two to four feet were frequent; lines of from seven to ten feet occurred many times; and in one case it was found that the line on measurement was twenty-six feet. Sometimes lines had been stretched across country roads from thirty to forty feet in length.

About twelve years ago a French missionary interested in silk culture from spiders' webs started a systematic rearing of two kinds of spiders for their webs. This web-factory is now in successful operation at Chalais-Meudon, near Paris, where ropes for balloons are made of spider-web; and these ropes are said to be of the strongest character possible. Twelve spiders are placed above a reel, upon which the threads are wound, and each spider is supposed to furnish from thirty to forty yards of thread before it is released. Then the web is washed to clear it of the outer rubbish and sticky cover. Eight of these washed threads woven together make a strong yarn cord, that is found excellently adapted for use in balloon service.

DREAMS THAT MAY BE WARNINGS.

Dr. Herman Swoboda, of Vienna, says Public Opinion, has recently provided us with some very interesting data in reference to dreams, data which may do a great deal in explaining many phenomena which up to the present have been looked upon as the work of mysterious agencies. This scientist believes that impressions and events are again brought into the field of consciousness after certain specified intervals, in the case of men after twenty-three days and in the case of women after twenty-eight days. Thoughts and recollections, on the other hand, have a periodicity which is apparently not explained in any way by examination of the customary train of ideas. The reproduction of impressions and recollections is so regular that Dr. Swoboda has frequently succeeded in predicting the appearance of certain dreams at specific times.

He himself always has the well-known "flying dream" twenty-three days after he has been skating, and it is probable that continual use of our arms and legs in other than in a normal manner, as in dancing, skating, bicycling, etc., will, after a period of twenty-three or twenty-eight days, produce the "flying dream." This form of dream is doubtless the result of the so-called muscular sense, for we possess a feeling not only of the position of our muscles, but also of the changes which these muscles undergo in movement.

However, the most remarkable part of Dr. Swoboda's work is its bearing on premonitions and the key it gives to the explanation of a large mass of this phenomena. Again we will resort to the cases mentioned by the author, which will indicate his meaning clearly and briefly. Dr. Swoboda tells of a case of a physician who dreams that he is called upon to see a sick child. The third of January the physician made a visit to the child under discussion, and the night of the 27th and 28th of March he had his dream. During his visit of the 3d of January he had received his impressions, which after the triple lapse of the period of twenty-eight days were again presented in the dream. At the same time the physician had his dream the mother of the child had a dream which represented the former visit of the physician, in the case of the physician the dream creating a premonition that he would be called to see the child, while with the mother there was suggested the advisability of calling in the physician.

A much more remarkable case, however, is that of a written correspondence carried on by Swoboda with a person at a distance. One day Swoboda's correspondent declared that he had foreseen in a dream the arrival of Swoboda's letter, and upon investigation it developed that the letters were written exactly twenty-three and forty-six days apart. From the time of starting the correspondence the time for the two writers was the same, a fact which indicates that the spontaneous recollection would lead the one who owed a letter to write the same, and the one who was to receive a letter to expect it, the next time the case being reversed. This fact will also explain why the letters written by the two men often crossed.

OIL PALM ON THE WEST COAST OF AFRICA.

The African continent seems to produce the greater number of vegetable growths which contain fatty or oily matter in a more or less fluid state. The fruits or other products of these plants are brought from the west coast of Africa by boat to Marseilles, Hamburg and Liverpool. The oil palm is one of the most valuable of the oil-producing varieties of the west coast. It extends from Cape Verde to Angola, over more than 3,200 miles of coast, and penetrates into the continent as far as the region of the great lakes. It is even found on the east coast. Proximity to the sea is not as necessary for the oil palm as for the cocoa tree, for in dry ground it grows very well. However, in the latter case it remains dwarfed and produces but little, while in damp soil it flourishes and yields its greatest output. The trunk of the tree has but little consistency and is of not much value. It is the grain or fruit which yields the oil. From the pericarp is extracted a yellowish oil, but the nut itself affords a white oil. In the Gulf of Guinea the main harvest of the fruit is from January to June. The natives only extract the yellow oil, while the white oil is taken from the nut in Eu-

rope. The yearly production of a plant in good condition is from 10 to 12 growths of the fruit, making in all some 200 pounds, which yields about 15 pounds of oil from the shell and 30 pounds from the nut. Other products are taken from the tree, such as palm wine and fibers. From the fibers of the young leaves are made baskets and waterproof cordage. In Europe the palm oil is used only for making soap and candles and not as a food product. When fresh, however, it has an agreeable taste and might easily replace olive oil for table use.

THE 1904 PARIS AUTOMOBILE SHOW.—I.

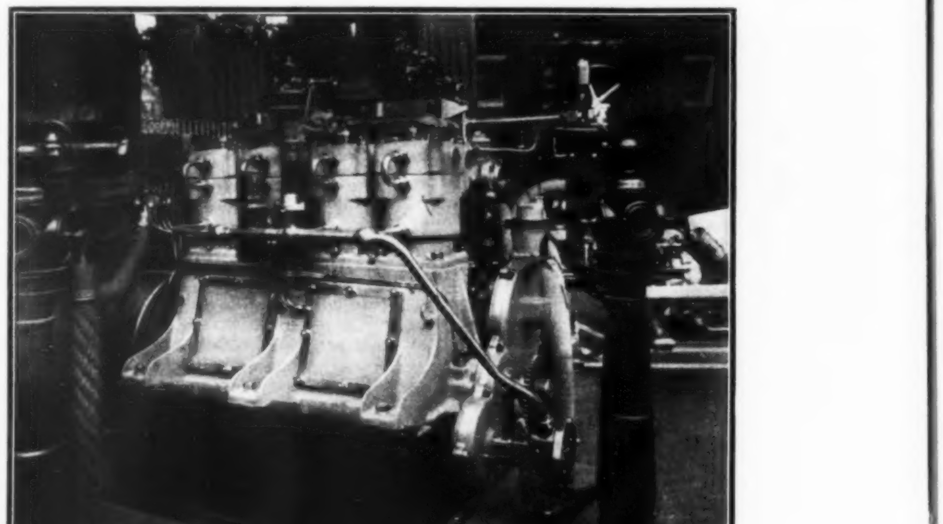
By the Paris Correspondent of the SCIENTIFIC AMERICAN.

AMONG the novelties of the recent Paris Automobile Show, which closed its doors on Christmas Day, are the new "Direct" cars, designed by M. Robert Goldschmidt, of which several are on exhibition. In this car the usual gear-changing box is suppressed, and the car is run by varying the speed of the motor. It has been found possible to vary the motor within the required limits of speed and also to reverse it for backward motion, and so obtain all the latitude required without needing to use the ordinary speed-transmitting gears. This is a considerable advantage as regards simplicity as well as economy, seeing that we have a much less friction loss. Another feature is the friction clutch for coupling the motor to the longitudinal driving shaft which drives a countershaft through a bevel gear, the final drive being by chains to the rear wheels. This clutch is designed on a new principle which gives a very easy and progressive movement. As regards the motor, it is a 40 or 50-horse-power one of the four-cylinder vertical type. The valves are all cam-operated and placed on one side of the motor. Regulation of speed is secured by modifying the lifting distance of the valves at the same time as the duration of opening. That is, at slow speed the valve only commences to open after the piston has made a part of its stroke. This result is obtained by using a conical cam whose shaft can be displaced by means of a handle on the driver's wheel. The cam serves as a stop piece which limits the movement of the valve. The motor is reversed by a second cam which is substituted for the other, the ignition current being cut off at the same time. As soon as the reverse cam is in place the current is made again, and the spark occurs in the cylinder at the compression period so as to reverse the motor. By simply shifting the cams, the car can pass through all the speeds from the slowest up to 50 miles an hour, and keep about the same speed on a grade as on the level.

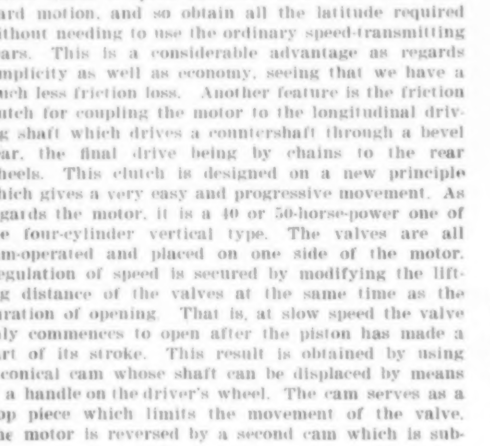
The new friction clutch is radically different from the usual cone-clutch. It is all-metal and therefore not likely to wear, and it gives a smooth and progressive movement. This is carried out by using friction disks which are applied successively from the center to the circumference, so that the car starts up with an ease which has not been obtained hitherto with a gasoline machine. The principle of the clutch will be readily understood from the following diagram of the essential parts. A steel disk, *A*, is mounted on the motor shaft. It works with a second disk, *A'*, which is mounted on the rear shaft, *D*. Between *A* and *A'* are three flat steel rings, *a*, *b*, *c*, which form friction surfaces with *A*. These rings are dovetailed together, but each can move independently back and forth. Each ring can be pressed against *A* by the corresponding button, *a'*, *b'*, *c'*. These pieces have a flat portion on their inner ends which is not shown here, also springs for bringing them back. Against the buttons presses the arm of a lever, *B*. The other arm is worked by the conical cam, *C*, which the lever, *L*, shifts to the left, while a spring, *S*, restores it to place. By operating the lever we bring the vertical arm of *B* first against *c'*, which presses the ring *c* against *A* near the inner and slowly-revolving part. The motor thus commences to drive the rear shaft. Then *b* and finally *a* are brought against the plate *A*, when the clutch is fully in action. In this way a very easy movement is obtained.

The Delaunay-Belleville car is built by a company which is already well known in boiler and engine construction, and has a large works near Paris. The new chassis which they have on exhibition has a most pleasing appearance from a mechanical point of view, and will no doubt uphold the reputation of this firm. The leading feature of the car is the method which has been adopted for consolidating the motor and mechanism. To carry this out the motor and speed-changing case are mounted together upon a concave plate of pressed steel. The latter is then attached to the chassis, which is also entirely of steel and forged in a very solid shape. The car body is held to the chassis by only four bolts, and can be taken off at once without interfering with any other parts. To this end, the motor, the water tank, and gasoline reservoir are placed together in the front of the chassis, thus reducing the piping to a minimum. The motor has four independent cylinders, and five bearings are provided for the crank shaft. Oiling is carried out by a system of circulation which uses oil under pressure, furnished by a patented form of oscillating oil-pump. The latter has already proved a success upon marine steam engines.

The Mildé Company has brought out a new type of electric car, which our engraving shows. The motor and method of transmission are the points which offer the most interest in this case. The motor is mounted in the back part of the car, in front of the rear axle. It is of improved design and combines two motors in one. It has two independent armatures running in a single field. The armatures are mechanically separated, and each drives one of the rear wheels. The field of the motor is excited by lathe-wound coils which are placed on one side, and the magnetic circuit is completed through the other half. This arrangement allows of a good balance on the two armatures, even when the fields are worked in shunt, as is sometimes the case. Each motor shaft has a pinion on the outer end which gears with a large wheel in the ratio of 5 to 1. The latter gear is mounted on a countershaft. At the end of the latter is a sprocket from which a chain passes to the rear wheel of the car. The use of chain driving for electric motors has several advantages which led to its adoption here. One of these is the high efficiency as compared with direct driving by gears from motor to car wheel. Another lies in the

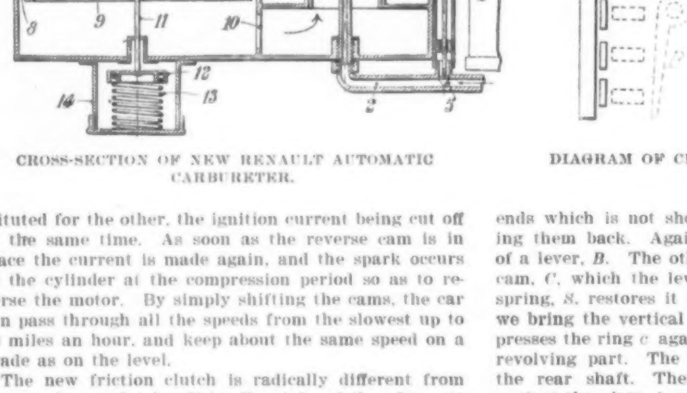


SIXTY-HORSE-POWER WOLSELEY KEROSENE-OIL MARINE ENGINE.

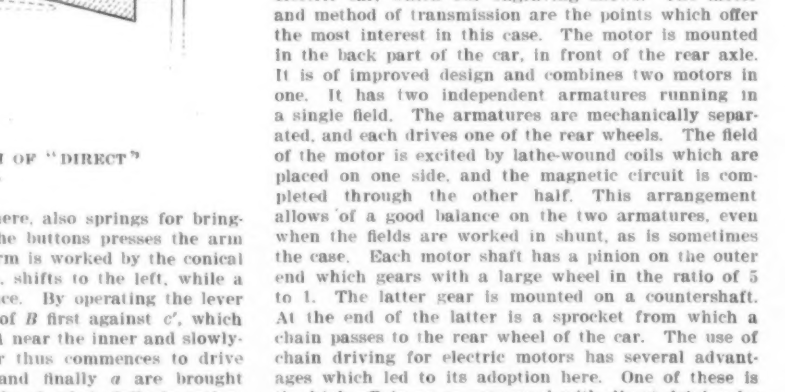


CROSS-SECTION OF NEW RENAULT AUTOMATIC CARBURETER.

DIAGRAM OF CLUTCH OF "DIRECT" CAR.



MILDE ELECTRIC COUPE WITH TWIN ARMATURES RUNNING IN A COMMON FIELD.



CHASSIS OF "DIRECT" AUTOMOBILE, ON WHICH THE TRANSMISSION GEAR IS REPLACED BY A REVERSIBLE GASOLINE ENGINE AND SPECIAL CLUTCH.

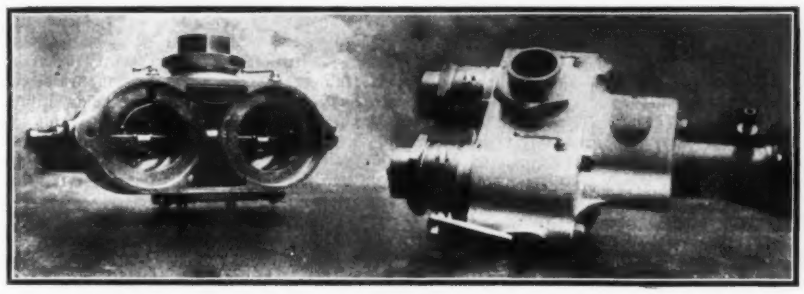
NEW FRENCH CARS AT THE PARIS AUTOMOBILE SHOW.

fact that the motor can be attached rigidly to the chassis and thus has the benefit of the spring suspension, while in the case of direct driving the motor is suspended to the axle, and receives all the shocks of the latter. This gives it a very hard wear, and it is even found that the metal undergoes a molecular change. Sometimes the aluminium of the case becomes very hard and brittle. Another point is the easy adjustment of the chain, while with direct gears these have to be adjusted to within 1-250th inch if the car is to run without noise.

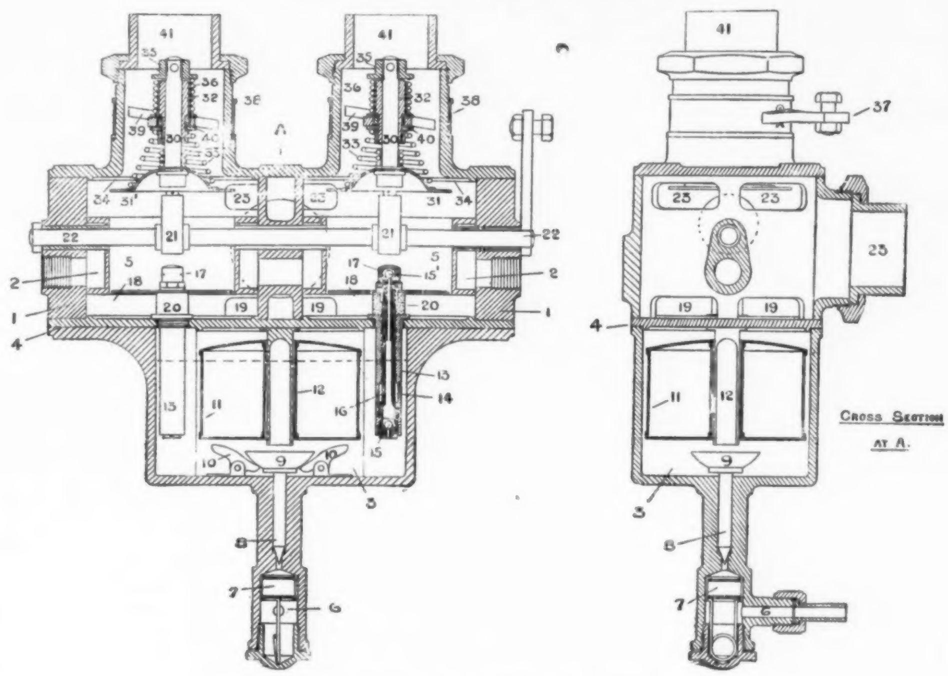
The motors are built to receive 35 or 40 amperes current in the two armatures when these are coupled in parallel, and can support as high as 180 amperes without overheating. The motor weighs 500 pounds when complete with gearing and sprocket wheel. The bearings give but little friction owing to their great length, which is 4½ times the diameter of the shaft, and also by the use of oil-rings. The elongated form of the motor gives more room for the working parts, instead of having to crowd these together as in the case where two motors are used. In spite of the fact that the motors are now united, they are independent in one sense, that is, if an accident happens to one of them the other will be able to run the car alone. The controller of the Mildé car is designed to give a considerable number of speeds, so that it will be easy to handle the car in the city. There are, in fact, eight working speeds, besides two recuperating points, where the motors work as dynamos when going down grades, two positions of electric braking, and three reverse speeds.

The "Motobloc" system, which made its first appearance last year, has now been applied in a four-cylinder motor of entirely new design. The Motobloc contains some valuable features. As its name indicates, it combines the motor, transmission gear, and all the mechanical parts belonging to the two, in a single compact piece which is fixed to the front of the chassis. To carry this out, the motor case is extended in length in the rear part so as to form a second compartment just back of the crank case. The latter case contains speed-changing gears. This arrangement has a number of advantages which will be readily seen. The *ensemble* thus formed is very solid and gives a great protection against shocks of running, especially as regards the bearings of the main shaft, which are now made solid together, and sticking of the shaft becomes almost impossible. All the parts now run in oil, and this is especially good for the friction clutch, which is no longer exposed to dust. Inside the case the "Motobloc" thus carries the crank shaft, flywheel, friction clutch, and gears for three speeds and reverse. On the outside are placed the carbureter, water pump, a second flywheel combined with a fan, the magneto, and the muffler. The inner flywheel is mounted between two bearings and in the middle of the crank shaft. The latter thus has four bearings, which secures a favorable condition. A new feature is the method of regulating the inlet valves of the motor. These valves are placed on top, and at the end of each cylinder. For each valve, a cam on the countershaft of the motor works a vertical rod which passes up to the top and from there it operates the valve by means of a lever. At this point is a revolving cam which limits the upward movement of the valve. The cam is shifted by a lever. In this way the inlet of gas can be varied without any complication and it secures an economy of fuel when at slow speeds, as well as the silent running of the motor. This operation is carried out from the ball-governor of the motor, or by hand. The friction clutch is entirely metallic and consists of two pieces which are forced apart inside a cylinder which the motor shaft carries, thus connecting the rear shaft with the motor. As the clutch runs in oil it does not get out of order as readily as the ordinary clutch.

Besides a number of standard cars and chassis, the Wolseley Company, of England, have a very handsome upright motor on exhibition. This motor, which is shown in one of the engravings, has been recently designed for use on a launch, and one of the features to be noted specially is that it uses kerosene for fuel. This is a field in which many inventors are now working in Europe, and the new motor is claimed to solve the problem, and to run very efficiently with heavy oil. It is built to furnish 65 or 70 horse-power, and is a four-cylinder motor, running at about 600 revolutions per minute. One of the main features is the carbureter and vaporizer for the oil. This apparatus is placed in the front of the motor. In the lower part is the carbureter, consisting of a cylindrical chamber. A pipe leads up from the carbureter to the vaporizing chamber. The latter communicates with the four cylinders of the motor by piping. It is provided with a special throttle which is controlled by hand by means of a rod projecting from the side of the chamber. The motor is of the usual four-cycle type with inlet and exhaust valves all mechanically operated by the use of cams and trip-levers. The inlet valve is placed at the top and the exhaust at the bottom of the valve chamber. The combustion head as well as the cylinder proper is surrounded by a water jacket. Ignition is carried out by induction coil and spark plugs. The contact box for the four cylinders is contained in a compact case which is readily accessible by taking off a cap. It is operated by gearing from the main shaft, while another set of gears work the turbine pump for the water circulation. The lubrication of the motor is carefully carried out. A very complete sight-feed oiler is provided with a number of pipes which secure a circulation in all the working parts.

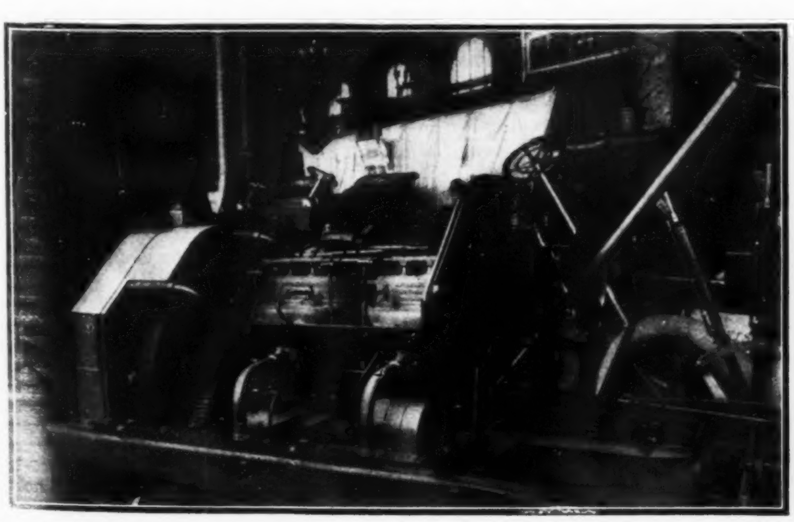


TWO VIEWS OF THE ARGYLL CARBURETER.

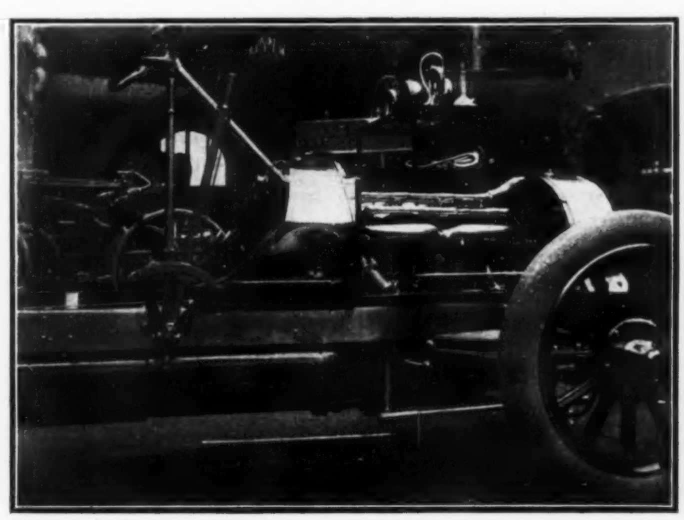


CROSS-SECTIONS OF ARGYLL CARBURETER.

The Renault Company show a number of very handsome cars this year, which contain many improvements in detail. In the main lines the system keeps the leading features which have already been described. The carbureter is entirely new, however, and the engraving shows a sectional view. The main points are the method of automatic regulation by the use of a revolving valve on the air-feed, and the combining of all the parts in a single apparatus. At 1 is seen the float chamber, from which the gasoline comes by the tube, 2, into the atomizer, 3. The latter is placed in the cylinder, 4, contained in the mixing chamber. At 21 is the inlet pipe to the motor. A needle-valve, 5, is worked by a lever to shut off the gasoline feed. The air enters the regulating chamber, 6, by the openings, 7. These openings are sufficiently large to allow a greater inlet than the motor needs. The air which comes to chamber, 6, by the openings, 7, traverses the annular space, 8, between disk, 9, and the interior of the chamber. It then passes by the opening, 10, into the cylinder, 4, of the mixing chamber. The diameter of the disk, 9, relative to chamber, 6, is such that the section of the annular space, 8, is about equal or less than the section of 4. In consequence, the suction of



"MOTOBLOC" CAR HAVING ENGINE CRANK CASE AND TRANSMISSION GEAR CASE IN ONE PIECE. IGNITION MAGNETO IS SEEN AT BOTTOM OF DASH AND FORCE FEED OILER MOUNTED ON IT.



THE DELAUNAY-BELLEVILLE CAR—ONE OF THE NEW FRENCH MODELS, HAVING THE ENGINE AND TRANSMISSION MOUNTED IN A STEEL PAN WHICH THOROUGHLY PROTECTS BOTH.

NEW FRENCH CARS AT THE PARIS AUTOMOBILE SHOW.

the motor tends to draw down the disk, 9. The latter is fixed on the rod, 11, whose lower end rests by a cap upon a spring, 13. Above, it carries a high-pitched thread, 15. The rod also carries a cylinder, 16, which controls the entry of air through a set of holes, 18, in an upper cylinder. The holes give a communication between the chamber, 6, and the upper chamber, 19. When the holes, 18, are uncovered, a part of the air coming in through the openings, 7, is drawn by the motor through the holes, 18, and the orifice, 20, and is added to the mixture passing through 4 to the motor. This second supply is regulated by the suction of the motor. When the suction increases, it draws down the disk, 9, against the spring. The greater the suction, the more the cylinder, 16, is depressed and opens the air holes, 18. The upper part of the rod is threaded so as to avoid sudden movements of the disk, 9. The vertical displacement of the latter can only occur in combination with a rotary movement of the disk, which prevents it from vibrating, and thus it works regularly and slowly upon the upper air-cylinder and controls the extra air inlet without being exposed to all the shocks of the motor. The arrangement of the regulating disk allows a considerable play between the latter and the cylinder in which it works, and thus suppresses all friction between the two. In this way a great sensitiveness is obtained in the regulation.

Among the English cars at the show is the Argyll, which is manufactured by the Hozier Engineering Company. The new type of carbureter is one of the features of the Argyll car which is specially worth mentioning. Two sectional views of it are shown here. The features of this device are the positive feed of the gasoline which is secured, and a new arrangement for governing the motor. Below is the float chamber, into which the gasoline is fed from below, and kept at the level of the dotted line. It comes in from the tank by the tube, 6, and passes up through the strainer, 7. The latter can be taken out for cleaning by unscrewing the lower cap. The usual needle-valve principle is used to secure a constant level of gasoline. Into the chamber project the feed-pump barrels, 13, provided with plungers, 14. As the piston works it causes a suction, creating a partial vacuum in the inlet pipe, 41. This causes hot air to come in from the pipe, 23, through the openings, 19, and up through a set of holes in the disk, 18. The latter is fixed to the pump plunger, 14. The latter has below a ball suction valve, 15, and above the entry valve, 15. When the incoming air lifts the disk, 18, it also raises the plunger, and the latter brings the gasoline from the annular space, 16, through valve, 15, and sends it out through the atomizing holes in the cap, 17. The size of the annular space determines the supply of gasoline for each stroke and this is fixed in advance for the running conditions and kind of gasoline used. A cam, 21, operated by shaft, 22, allows, however, of adjusting the supply for other conditions. This stop cam determines the amount of lift of the plunger and of the maximum amount of gasoline for a stroke. The mixing chambers, 5, are warmed by a hot air jacket, 2. In each inlet pipe is placed a speed-governing device which replaces the separate centrifugal governor commonly used. A spindle, 30, carries the disk valve, 31, held off its seat by the springs. At slow speed of the motor, the air flows past this valve, but at higher speeds a partial vacuum is formed, and when this counterbalances the springs, the valve, 31, closes on its seat, cutting off the mixture to the motor. When once closed, it cannot then open during a given stroke, as the further movement of the piston holds it seated still more tightly, and this causes a cut-off action for the gas after a given speed is reached, thus slowing down the motor. Below this the governor does not come into action. To control the governing point, the distance between the valve and its seat is changed. The more the valve is closed, the greater will be the vacuum formed, and it will thus come into play at a slower engine speed. To adjust it, the lever, 37, is used, operated by the driver. The lever works the sleeve, 38, from which a pin projects inside through a curved slot, 39. The pin engages in a groove in a collar, 40, on the valve-rod. Turning the lever, 37, raises and lowers the pin and changes the amount by which the valve can open, and therefore the governing speed. The two levers, 37, are connected together. Several advantages are claimed for the new apparatus. It is simple and compact, avoids a centrifugal governor, and gives a correct mixture under all conditions. It acts very quickly and secures a proper feed of gas even though the speed is changed rapidly. It is also claimed to give an economy of 25 to 35 per cent in fuel.

TARRING ROADS TO PREVENT DUST AND TO AID IN THEIR PRESERVATION.

WHILE there is nothing new in the fact that European highway authorities are using hot pitch as a road preservative and means of preventing the formation of dust, it is well to state that the first tentative efforts in this direction have resulted in the perfection of a system the excellence of which is beyond question. I have had frequent opportunities last summer to compare stretches of tarred and untarred highway, to the advantage of the former. The principal suburban boulevard of Marseilles has just been so treated. It is a popular error to describe the process as a mere sprinkling of hot pitch. It is equally an error to suppose that valuable results may be obtained by smearing hot pitch over loosely constructed gravel or clay roads. On the other hand, it may be expected that dust will be effectively banished from a well-built macadamized highway into which hot tar is thoroughly worked, and that repair cost will be diminished by from 25 to 40 per cent. In support of these observations, I give herewith some remarks from Road Commissioner Girardeau of Fontenay-le-Comte (Vendée), who has prepared a pamphlet on this subject:

The tarring of highways is no idle whim, but a method of maintaining them which should be placed in the foreground with other details of maintenance. As roadways are shaped and surfaced, they should be tarred. Much time will pass before this method is adopted, in spite of the certainty of acquired results. The object of banishing dust is praiseworthy enough in itself, but since we may do this while also solidifying and improving our highways, the system should be well received by all who are interested in our public routes. My method is not to hold down the dust for two days, a week, or a month—it is to prevent its formation.

I do not comprehend how the separation of the fight against dust and the maintenance of the highways can be considered. That which forms the dust arises from the disintegration of the road. A road without dust is one that does not wear out, or at least does so imperceptibly.

First of all, let me proscribe a coal tar subjected to one distillation, that is to say, deprived of the light oils of the raw material. These oils are no less valuable for their effect in the road-tarring operation than they are in the industries. It is indispensable to employ undistilled pitch, which boils at about 80 deg. C. (176 deg. F.).

This product should be brought to a temperature approaching that of ebullition, since in this condition it is most mobile and penetrates best into the material of the roadway. To spread a pitch at 60 deg. C. is a grave error; on the other hand, at 80 deg. C. it is easily inflammable and spills over the side of the boiler. This inconvenience I have avoided by having a special apparatus made by Chappée & Co., of Mans, which permits of the watching and regulation of the heating. This device is light and, being mounted on wheels, is easily transported.

The pitch leaving this apparatus while boiling is spread upon a roadway prepared to receive it. The workmen must aim not to cover the surface as with a carpet, by spreading on it a thick layer, but rather to cause the tar to penetrate the highway itself. This result depends upon proper preparation of the road surface and the careful spreading of the hot tar.

It is preferable to work upon a resurfaced road or certainly one in good condition. All work must cease if the ground be cold or damp. A heedless spectator might be delighted with the first aspect of his work upon a damp surface, as the pitch would promptly form a smooth carpet. Such work scarcely lasts through one summer, however, and goes to pieces with the first frosts. A thoroughly dried roadway must be taken, such as we have in July, August and September. From the surface every particle of dust must be removed. Ordinary mechanical sweepers are not proper for this task. Metallic-thread brooms are equally out of the question. We must have a sweeping material less hard than the road surface, in order to clean without breaking it.

The pitch should be distributed from the center of the roadway. It should be poured, not sprinkled. The sprinkler is exactly the instrument which should be selected if the object were to chill the coal tar as quickly as possible. It is a very simple matter to pay out the pitch in small quantities and to spread it immediately upon the surface. The pitch penetrates well into the joints and impregnates thoroughly the whole roadbed. This process is aided by rubbing it in energetically with stiff brooms, which open the joints and conduct the pitch. One must not be disquieted by the rough aspect of the road surface—after several days it becomes united, compact and resistant. A very little sand, or even dust, thrown over the surface five hours after the dosing of tar completes the operation.

I have tarred roads for eight years, and have followed the above method for four years. My tarred roads last twice as long as those not so treated. The wear is imperceptible, especially during the first years. Certainly tarred roads do wear and need maintenance, and in my pamphlet I have set forth the conditions of this maintenance.

According to material composing the roadway and other conditions, the economy resulting from the tarring of roads varies from 25 to 40 per cent.

Inexperienced persons usually begin by spreading a great deal of pitch, thinking to get better results. In reality they expend their money to obtain an ephemeral success.—Robert P. Skinner, Consul-General, Marseilles, France.

TIME SIGNALS BY WIRELESS TELEGRAPHY.—G. Bigourdan makes a proposal for the wireless distribution of time signals, which he has already subjected to some satisfactory tests. The directing clock, which breaks an electric contact every second, works a relay which, in its turn, sends a current into the primary circuit of an induction coil furnished with an oscillator. The secondary circuit of the coil thus provides an oscillating discharge of very short duration, which passes regularly every second. One of its poles is earthed, while the other is connected with an antenna several meters high. The author tried two different receivers, one of them being a Popoff-Ducretet radio-telephone, while the other was an ordinary wireless receiver provided with a band chronograph passing 1 centimeter of band per second. He obtained satisfactory transmissions over a distance of 2 kilometers. In view of the accuracy of modern chronometers, the author does not consider it necessary to number the minutes, but he would make an interruption at every tenth second. He points out the advantages which a general use of such a system of distribution would confer upon watchmakers and the makers of scientific instruments of precision.—G. Bigourdan, Comptes Rendus, June 27, 1904.

[Continued from SUPPLEMENT No. 1513, page 24240.]

ON THE MODERN REFLECTING TELESCOPE, AND THE MAKING AND TESTING OF OPTICAL MIRRORS.*

By G. W. RITCHEY.

X. POLISHING.

THE preparation of polishing tools has already been described. The polishing rouge which I use is of the quality which is used in large quantities commercially in polishing plate glass. I prefer the powdered form always. This grade of rouge is not expensive (it costs about 30 cents per pound), but, like all rouge which I have seen, it contains hard, sharp particles which may cause scratches. It must therefore be thoroughly washed in the following manner:

In a clean, deep bowl *C* enough rouge is placed to fill it about one-third full; the bowl is then nearly filled with distilled water. The mass is very thoroughly stirred with a clean wooden paddle, and allowed to settle for about twenty minutes. The water above the rouge will now be perfectly clear; this water is siphoned off. With a clean spoon the light and fine rouge constituting the upper one-third of the precipitated mass is removed, and placed in a second clean bowl *D*. The rouge remaining in *C* may be again stirred up with an abundance of distilled water, and allowed to settle as before, the water siphoned off, and the upper one-fourth of the precipitated rouge removed and placed in *D*. The heavier rouge which remains in *C* is about half of the original quantity taken; this is usually reserved, and, after further washing, is used for polishing the backs of mirrors, and for similar work. Only the contents of the bowl *D* are used for fine work, and these are stirred up again and again with distilled water during the process of polishing, and only the fine, soft cream which remains on the top of the mass of rouge, when it settles each time, is used for polishing.

The thin cream of rouge and distilled water is applied to the glass by means of a wide brush consisting of a thin paddle of wood with clean cheese-cloth wrapped and tied about one end. Brushes of the usual kind should not be used.

By taking these precautions, and by the use of the wax surface on the rosin squares, scratches in polishing can be entirely avoided. It is true that the very light, fine rouge polishes more slowly than the heavier and coarser rouge, but an exquisitely fine polished surface is produced on the glass by its use. The wax surface also polishes more slowly than a bare rosin one, but it has the very great advantage that its action is more smooth and uniform than that of the rosin surface; the latter often tends to cling to the glass, and this unequally in different parts of the stroke.

The same question arises in regard to the size of polishing tools as in the case of grinding tools—whether they shall be full size or smaller. In the writer's opinion fine plane and spherical surfaces up to about 36 inches in diameter are best polished with full-size tools, which are moved by hand, by the optician and one or two assistants, upon the surface of the slowly rotating glass. The upper parts of the machine are, of course, removed during such polishing, which I shall call manual polishing.

A 24-inch polishing tool, prepared as already described, with its wooden basis 2¾ inches thick, weighs about 25 pounds; this is not heavy enough for the best action in polishing; so about 50 per cent additional weight is put on in the form of 12 lead blocks which are distributed uniformly and screwed to the back of the tool. This gives a weight of about 1-12 pound for each square inch of area, which is found to work well for all large tools. For tools 18 inches or less in diameter somewhat greater pressure per square inch of area may be used. A 36-inch tool, with wooden basis 3¾ or 4 inches thick, weighs 75 or 80 pounds, and needs no additional weighting.

The work of polishing a 24-inch mirror with full-size tool will now be described. Six strong knobs of oak wood are screwed to the back of the wooden basis, each knob being at the center of weight of each sixty-degree sector of the tool. These knobs serve for pushing, pulling, and lifting.

The polishing tool, which, with the glass, should have cooled over night after the warm-pressing or rough-pressing previously described, is now to be cold-pressed. Cold-pressing is absolutely necessary in all fine work on large optical surfaces. In warm-pressing, both tool and glass are distorted by even slight warming, and when they become cool a perfect fit cannot be expected. The glass is carefully wiped with clean cheese-cloth, and an abundance of very thin mixture of rouge and water is spread upon it. The tool is now placed upon the glass and allowed to lie for several hours, being moved about slightly every ten minutes to redistribute the rouge and water, and to prevent the latter from drying around the edges. The pressing may be assisted at first by means of a 20 or 30-pound weight, the pressure of which must be distributed by some such means as three bars laid upon the six knobs, and a triangle, carrying the weight, laid upon these. The final cold-pressing must be done by the weight of the tool alone. The tool is taken off and examined occasionally; when it is sufficiently pressed the wax

* Reprinted from vol. xxxiv, Smithsonian Contributions to Knowledge

surface appears uniformly smooth and bright. So perfect a fit is secured in this way that there is no danger of injuring the form of the glass when polishing is begun. This applies to all stages of polishing and figuring. A fresh supply of rouge and water is now spread upon the glass.

The stroke of the 24-inch polishing tool is easily given by the optician and one assistant, who sit on opposite sides of the machine; the glass slowly rotates with the turntable, making about 2 revolutions per minute. The knobs on the back of the tool are held in the hands, and the stroke is given by alternately pushing and pulling; no vertical pressure whatever should be given by the hands. In addition, a considerable side-throw is always given, first to one side, then to the other; this greatly assists in preventing the formation of zones of unequal curvature. Polishing may be begun with a stroke 6 inches in length, which of course causes the tool to overhang the glass 3 inches at the ends of the stroke; between 20 and 25 double strokes per minute are given. The side-throw used with this length of stroke is about 2 inches, i. e., the tool is made to overhang the glass about 2 inches, first to the right, then to the left; the time occupied in passing from the extreme right to the extreme left is about what is required for 4 double strokes. This stroke and side-throw are continued while the glass makes exactly 2 revolutions; the tool does not rotate with the glass, of course, while the stroke is being given; the last stroke should end with the tool central upon the glass.

Tool and glass are now allowed to rotate together for 5-6 of a complete revolution, and each optician then grasps the pair of knobs next to that which he held before, so that the stroke is now given along a diameter of the tool 60 deg. from that last used; the length of stroke is now changed to 7 inches, and the side-throw to 2½ inches, and polishing is again carried on during exactly 2 revolutions of the glass. Tool and glass are again allowed to rotate together for 5-6 of a revolution, and polishing during 2 revolutions is now done with a stroke of 8 inches and side-throw of 3 inches. During the next periods of polishing, each of 2 revolutions of the glass, the stroke and side-throw are gradually shortened until a stroke of 4 inches or less is reached; then the length of stroke is increased again.

When polishing has been carried on during 6 or 8 periods of 2 revolutions each, it will be found necessary to supply more rouge. The only entirely satisfactory method of doing this, when a full-size polishing tool is used, is to remove the tool from the mirror, and quickly spread the thin cream of rouge and water upon the glass as uniformly as possible with the cheese-cloth brush. The removal of the tool is effected by the two opticians carefully sliding it off the mirror, and lifting at the same time. The tool should be allowed to remain off the glass for only as short a time as possible, so that the form of the latter shall not be altered as a result of a change of temperature of the surface, caused by evaporation. For this and other reasons, such as the prevention of dust, the air in the polishing room should be kept moist by keeping the floor well sprinkled.

When the tool is replaced on the mirror it is lifted by both opticians so that only a very small part of its weight remains on the glass, and is lightly moved about, for 30 seconds or more, to distribute the rouge and water thoroughly before polishing is continued. As before stated, the method just described is the only entirely satisfactory one, known to the writer, of supplying rouge during the polishing with a full-size tool. All methods of supplying rouge at the edge, or through holes in the tool, are inadmissible when the greatest refinement of figure is required.

It is in order that they may be easily handled in the manner described that full-size polishing tools should be made light. It would, of course, be possible to devise mechanism by which tools of any size and weight could be sufficiently counterpoised, could be moved about upon the glass, and could be removed from the latter for the purpose of supplying rouge. The simple and economical method which I have described, however, works well for mirrors up to 36 or 40 inches in diameter. For large mirrors it is more economical, in the opinion of the writer, to use half-size tools for obtaining a fully polished spherical surface, and the same and smaller tools for parabolizing. The method of using these will be described later.

In general, it is much easier to prevent the formation of zones, and to eliminate zones already present, with full-size polishing tools than with smaller ones. The method of manual polishing just described, in which the length of stroke and the amount of side-throw are very frequently changed, tends to give a spherical surface, except for a zone around the edge of the mirror one-half an inch or less in width; this part of the surface will be of too great focal length, i. e., will turn down or back slightly, unless means are taken to prevent it. This tendency is most pronounced when a long stroke is used to excess, or when the rosin squares are too soft. It is entirely prevented by diminishing the area of the rosin squares around the edge of the tool, by trimming their edges to such a form as is shown in Fig. 4. The exact amount of trimming required depends upon the length of stroke, hardness of rosin, and temperature of polishing room, and therefore can be exactly determined only by experience.

A 24-inch mirror which has been properly fine-ground with emeries down to 2-hour or 4-hour washed, is readily brought to a perfect polish with a full-size tool in from 2 to 4 hours of actual polishing. If several broad zones of different focal lengths have resulted from the fine-grinding, as frequently happens, these zones can be gradually eliminated by a continuation of the use of the full-size polisher as above described.

Attention must be given to the rosin squares, which gradually press down so that their edges must be trimmed to keep the grooves of their original width and of uniform width. When the bare rosin begins to show at the corners or edges of the faces of the squares, which will occur after 6 or 8 hours' use of the tool, a new coat of wax must be applied, and the tool must again be thoroughly cold-pressed. It must not be supposed, however, that cold-pressing is necessary only at such times; in all fine work this pressing must be done whenever the tool has remained off the glass for more than a few minutes; after hanging face down during the night the tool is always cold-pressed for about 2 hours before polishing is begun in the morning.

Polishing with half-size or smaller tools is best done with the machine, instead of by manual work. These tools do not have to be removed from the glass in order to renew the supply of rouge; they are therefore connected to the machine and used very much as half-size grinding tools are used; in my work they are made of such weight that they need not be counterpoised. Very large or unusually heavy polishing tools of this kind can, of course, be easily counterpoised when desired.

Great experience, constant attention to very frequent changing of position of the tool by means of the transverse slide, and frequent testing of the form of the mirror surface are necessary in polishing with half-size or smaller tools, in order to preserve the uniform curvature of the surface. This is greatly facilitated by trimming the rosin squares at and near the edges of the tool, as in the case of full-size tools, but to a greater extent; the effect of the action of the edges of the tool is thus softened or blended.

When a half-size or smaller tool has just been coated with wax, or is known to be far from the exact form desired, it is first cold-pressed in the usual way on the center of the glass. But the final cold-pressing of such tools should be done as follows: The entire surface of the glass is painted with rouge and water, and the machine is set to give a "normal" stroke, i. e., one by which the tool is made to cover the entire surface of the mirror as uniformly as possible (without an excess of action on any zone) as the glass revolves; the machine is run extremely slowly, and the setting of the transverse slide is changed often; after pressing the tool for an hour or two in this way, polishing or figuring is to be begun.

XI. TESTING AND FIGURING SPHERICAL MIRRORS.

Before describing the work of figuring concave mirrors, which is done with polishing tools, it will be necessary to consider methods of testing. The principles involved in testing concave mirrors at their center of curvature by Foucault's method have been thoroughly explained and illustrated by Draper on pages 13 to 19 of his book, and by Dr. Common in his book "On the Construction of a Five-Foot Equatorial Reflecting Telescope." Foucault's original paper on this subject may be found in Vol. V. of the "Annals of the Paris Observatory."

All mirrors, when being tested, are placed on edge, so that the axis of figure is nearly horizontal, large mirrors being suspended in a wide, flexible steel band, lined with soft paper or Brussels carpet; for glass mirrors larger than 30 inches in diameter it is very desirable to have the grinding and polishing machine so constructed that the glass can be turned down on edge for testing, in the manner shown on Plate I, without removing it from the machine. A 30-inch glass mirror 4 inches thick weighs about 260 pounds; mirrors larger than this are difficult to handle without suitable mechanism.

A small, brilliant source of light, or "artificial star" may be produced by placing in front of the flame of an oil lamp a thin metal plate in which a very small pinhole has been bored. If the illuminated pinhole be placed about an inch to one side of the principal axis of the mirror, and at a distance from the mirror equal to its radius of curvature, a reflected image of the pinhole will be formed on the other side of the axis, and at the same distance from it and from the mirror as the corresponding distances of the pinhole itself. If the surface of the mirror is perfectly spherical, and if there are no atmospheric disturbances in the course of the rays, the reflected image, when examined with an eyepiece, will be found to be a perfect reproduction of the pinhole, with the addition of one or more diffraction rings around it, minute details of the edge of the pinhole appearing as exquisitely sharp and distinct as when the pinhole itself is examined with an eyepiece. If the eyepiece be moved outside and inside of the focus, the expanded disk in both cases appears perfectly round. Nothing can be more impressive than to see such a reflected image produced by a fine spherical mirror having a radius of curvature of 100 feet or more. Several such mirrors of 2 feet aperture have recently been finished here.

The use of an eyepiece is interesting for such experiments as that just described, and is important as a check upon the test with an opaque screen. The latter test, however, which I shall call the knife-edge test, is used almost exclusively for mirrors of all forms; it is far more serviceable than the eyepiece test in determining the nature and position of zonal irregularities, and is far more accurate in determining the radius of curvature either of a mirror as a whole, or of any zones of its surface.

If the eye be placed just behind the reflected image of the illuminated pinhole, so that the entire reflected cone of light enters the pupil, the polished, unsilvered mirror surface is seen as a brilliant disk of light. Let an opaque screen or knife-edge be placed in the same plane through the axis as the pinhole, and be moved across the reflected cone from the left, and just in front of the eye; if a dark shadow is seen to advance across the mirror from the left, the pinhole and knife-edge are inside of the best focus, and must be moved together away from the mirror; if, however, with the knife-edge still moved across from the left, the shadow advances across the mirror from the right, pinhole and knife-edge are outside of the focus and must be moved toward the mirror. By repeated trials a position is found from which the shadow does not appear to advance from either side, but the mirror surface darkens more or less uniformly all over; this is the position or plane of the best focus, and it is with this position of the knife-edge that irregularities of the surface, if any exist, are seen in most highly exaggerated relief; with this position of the knife-edge, the mirror, if perfectly spherical, is seen to darken with absolute uniformity all over as the screen is moved across the focus, and the impression of a perfectly plane surface is given to the eye.

If, however, the mirror is not perfectly spherical, but contains several zones of slightly different radii of curvature, a very common case, these zones will appear as protuberant or depressed rings on an otherwise plane surface. The reason for this is evident; the light from some parts of such zones is cut off by the knife-edge before, from other parts after, the illumination from the general surface is cut off; the surface is therefore seen in light and shade, i. e., in enormously exaggerated relief. The mirror must be regarded as being illuminated by light shining very obliquely along the surface from the side opposite that from which the knife-edge advances across the focus. The interpretation of lights and shades becomes easy after a little experience; not only is the character of a zone—whether it is an elevation or depression—readily seen, but its diameter and its width are readily determined.

If the disk of glass is of sufficient thickness and of proper quality, and if attention has been given to the uniform rotation of the turntable and to the protection of the glass from abnormal conditions of temperature during grinding and polishing, all irregularities of figure which occur are perfect zones or rings concentric with the edge of the glass; that is, the surface is always a perfect surface of revolution. If, however, these precautions have not been taken, or if the glass has been improperly supported during grinding and polishing, or if it has been cut out of thick rolled plate glass, so that it is weak in the direction of one diameter, an astigmatic mirror may be produced, in which the radius of curvature is slightly different along two diameters at right angles to each other.

Astigmatism is easily recognized with either the knife-edge or the eyepiece test. Let the plane of the apparent focus be determined with the knife-edge advancing from the left, then from above, then from the right, then from a number of directions between these three; if astigmatism exists the planes of the various foci thus found will not coincide; and the directions of greatest and least curvature of the surface are readily determined. When the eyepiece test is used, an astigmatic mirror does not give a sharp image even at the best focus; if the eyepiece be moved outside and inside of this focus the expanded disk becomes elongated, and is not uniformly illuminated; the direction of elongation outside is at right angles to that inside, and the distribution of light in the expanded disk is entirely different outside and inside of the focus.

The general character of the tests having now been described, let us consider some important matters of detail which are necessary for the greatest refinement in testing all forms of mirrors.

By the use of a small lens and a diagonal prism, in the manner shown in Fig. 1, the lamp can be kept well out of the way, and the illuminated pinhole and its reflected image brought very near to the axis of figure of the mirror. This is of much importance in testing mirrors of short focus or of great angular aperture, as the danger of errors in testing due to working considerably out of the axis of figure is avoided. As may be seen in the figure the pinhole is now placed at the surface of the diagonal prism nearest to the mirror being tested. The arrangement should be such that the cone of rays proceeding from the lens is considerably larger than is needed to fill the concave mirror.

When being figured, mirrors are usually tested while unsilvered, since very frequent tests are desirable. While the amount of light reflected from the polished unsilvered surface is surprisingly great, a much more brilliant "artificial star" than that given by the oil lamp is required for the greatest refinement and accuracy with the knife-edge test, especially in the cases of plane, paraboloidal, and hyperboloidal mirrors, in which there are two reflections from the unsilvered surface. It might be supposed that a larger pinhole could be used, and thus a more brilliant illumination of the mirror surface secured; but a large pinhole allows an apparent diffusion of light over the mirror surface, which obliterates all the more delicate contrasts of illumination due to minute irregularities of surface. With feeble illumination of the surface the eye is entirely unable to detect slight contrasts, which with brilliant illumination become strong and unmistakable. When the knife-edge test is used with an extremely small pinhole of between 1-250 and 1-500 inch in diameter, illuminated by acetylene or (what is much better) oxy-hydrogen or electric-arc light, minute

zonal irregularities are strongly and brilliantly shown, which are entirely invisible with large pinhole or insufficient illumination. With the arrangement of lens and diagonal prism (Fig. 1) either of the sources of light named can be used without difficulty; disturbances of the air from their heat should be prevented by placing the light behind a partition with a window of thin plate glass.

With the best conditions of apparatus just described, the degree of accuracy to be attained with the knife-edge test is surprising. With a mirror of 2 feet aperture and 50 feet radius of curvature, the plane of the center of curvature can be easily located to within 1-100 inch, and with care to within half of that amount. With the dimensions given, a change of 1-100 inch in the radius of curvature corresponds to a change of 1-500,000 inch in the depth of the curve of the mirror surface. There can be no doubt that zonal

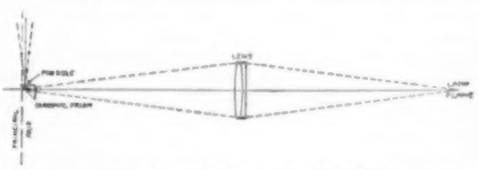


FIG. 1.—ARRANGEMENT BY WHICH ARTIFICIAL STAR IS USED VERY CLOSE TO OPTICAL AXIS.

irregularities of surface of half of this amount are readily recognized.

We are now ready to consider the finishing of a spherical mirror. As before stated, a continuation of the use of the full-size polishing tool tends toward the gradual elimination of zonal irregularities. This work is often slow and laborious, however, for when the mirror becomes nearly finished, so that any zones, when seen with the knife-edge test, appear as extremely slight elevations or depressions, the improvement becomes exceedingly slow. The work may be facilitated by the local use of very small polishing tools upon protuberant zones. These tools are usually from 2 to 4 inches in diameter, and consist of squares of rosin upon a basis of brass; their faces are waxed and cold-pressed, and the squares around their edges are trimmed in order to soften or blend the action of the edges; small local tools with their surfaces trimmed as shown in Fig. 13 (in which the shaded parts represent the rosin) are excellent for the purpose. These local tools are used as follows: the positions and width

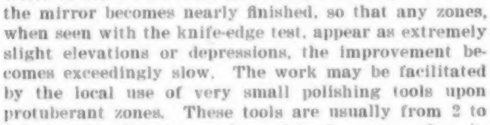


FIG. 2.—DIAGRAM ILLUSTRATING TESTING OF A PLANE MIRROR.

of any protuberant zones are carefully determined by the knife-edge test, and the glass is replaced on the rotating turntable; stationary pointers are clamped to the machine, and overhang the glass so as to indicate the exact positions of the zones; the surface is painted all over with rouge and water, and the optician works the small tools on the high zones by hand; the rubbing is done on each zone during several revolutions of the glass, the length and direction of the stroke being changed after each complete revolution. Great care and judgment must be used in this work, and the surface must be tested very often, otherwise a wide zone will usually give place to several narrow ones. After the protuberant zones have been softened down in this way the full-size polisher is again used for finishing the surface.

A large and perfect spherical mirror is an indispensable part of the equipment of an optical laboratory, as it affords what is in my opinion the most satisfactory

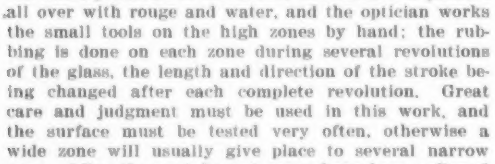


FIG. 3.—DIAGRAM ILLUSTRATING TESTING OF A PLANE MIRROR.

means of testing large plane mirrors. On account of the ease of rigorously testing a concave spherical surface, this is the form which should be first attempted by beginners in optical work.

XII. GRINDING, FIGURING AND TESTING PLANE MIRRORS.

The making of large plane mirrors of fine figure is usually regarded as much more difficult than that of large concave mirrors. The difficulty has been, in the past, largely one of testing. With a satisfactory method of testing the large plane surface as a whole, in a rigorous and direct manner, the problem is greatly simplified. So far as the writer is aware, no such test has hitherto been fully developed. In Monthly Notices, Vol. 48, p. 105, Mr. Common suggests, very briefly, the testing of plane mirrors in combination with a finished spherical mirror, and gives a diagram in illustration; but no details in regard to the method are given. This method has been developed and used for many years by the writer in testing plane mirrors up to 30 inches in diameter. When this test is used, the difficulty of making a 24-inch plane mirror which shall not deviate from perfect flatness by an amount greater than 1-500,000 inch is neither greater nor less than that of making a good spherical mirror of 2 feet aperture and 50 feet radius of curvature, when it is required that the radius of curvature shall not differ from 50 feet by a quantity greater than 1-100 inch.

A spherical mirror *A* (Fig. 2), which should not be smaller in diameter than the plane mirror *B* to be tested, is figured with the utmost accuracy, special care being taken that no astigmatism, however slight, exists in it. The mirror *A* is silvered; *B* is polished and unsilvered. The mirrors may be set up as shown in plan in Fig. 2, the distance $cm + mf$ being equal to the radius of curvature of *A*; both mirrors hang on edge in steel bands as already described. The light

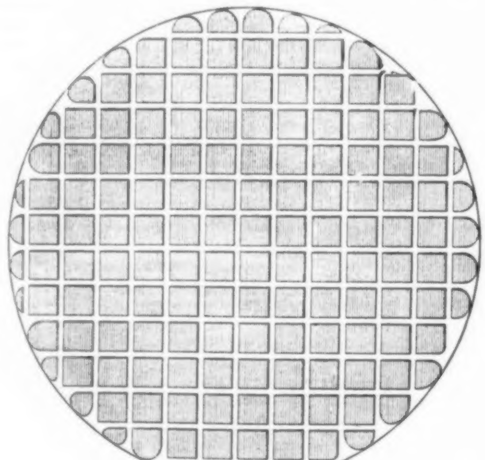


FIG. 4.—NORMAL POLISHING TOOL.

proceeding from the illuminated pinhole strikes *B*, is reflected to *A*, and thence back to *B*, thence to a focus close beside the illuminated pinhole.

When using the knife-edge test the optician sees the mirror *B* brilliantly illuminated, and in elliptical outline, the horizontal diameter appearing foreshortened by an amount depending upon the angle at which the mirror is viewed. With the knife-edge test the surface of *B* is seen in relief, as a whole; any zonal errors appear enormously exaggerated, and their character and position are readily determined, just as when a spherical mirror is tested at its center of curvature; these zonal errors, of course, appear elliptical, on account of their foreshortening; their effect is doubled in intensity on account of the two reflections from *B* (assuming that the illumination is as brilliant as the eye requires).

The test, as already described, is all that is necessary for the detection and location of zonal errors. But something more is necessary in order to detect general curvature, i. e., convexity or concavity, in *B*. Let us assume that the mirror, when fine-ground and polished, is so nearly flat that no curvature can be detected with a Brown & Sharpe steel straight-edge of the finest quality; and for convenience in description let us assume that the surface is free from zonal errors. Let the knife-edge be moved across the reflected cone from the left; a focal point is found at which the right and left sides of the mirror darken simultaneously; this focal point we will call f_1. Now let the

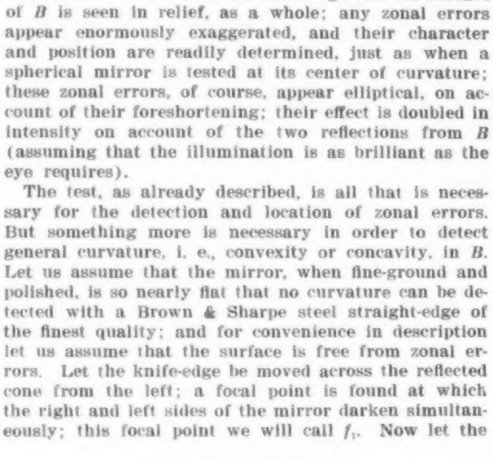


FIG. 5.—CONCAVING POLISHING TOOL FOR FIGURING PLANE MIRROR.

knife-edge be moved across the cone from above, instead of from the left; a focal point will be found at which the upper and lower parts of the mirror darken simultaneously; this focal point we will call f_2. It is only when the mirror *B* is a perfect plane that f_1 and f_2 coincide with each other and with the point *f* (see figure). If *B* is slightly convex, f_1 and f_2 are outside of *f* (i. e., farther from the mirror than *f*) and f_1 is outside of f_2. If *B* is slightly concave, both f_1 and f_2 are inside of *f*, and f_1 is inside of f_2. In practice, the exact position of *f* is not found (except incidentally when the plane mirror is finished), for this would involve the very accurate measurement of the large distance $cm + mf$. The determination of the positions of f_1 and f_2 with reference to each other is all that is needed.

That f_1 and f_2 do not coincide when *B* is convex or concave is due to the fact that the curvation of *B* is apparently increased or exaggerated in the direction of the horizontal diameter of the mirror, on account of its foreshortening in this direction, as seen from *f*; while the curvature in the direction of its vertical diameter is not thus exaggerated. The effect is precisely as if the spherical mirror *A* were astigmatic, the parts of the surface adjacent to the horizontal diameter having a different radius of curvature from those adjacent to the vertical diameter. This effect is so marked that an extremely small deviation of *B* from a true plane can be detected. For example, if *A* and *B* are each two feet in diameter, the radius of curvature of *A* being fifty feet as before, and if the angle which the line *fm* subtends with the surface of *B* is 45 deg., a deviation from a true plane of 1-350,000 inch in the surface of *B* is readily detected. If the angle of the mirror *B* be changed to 30 deg., as shown in Fig. 3, the accuracy of the test for general curvature is about doubled; the latter position, however, is not usually so convenient for determining the positions of zonal errors; for the greatest refinement, therefore, the stand on which *A* and *B* are supported is so designed that the positions of the mirrors can be quickly changed so as to give the greatest accuracy in each part of the test.

The use of an eyepiece in this test is important because it shows how fatal to good definition is even a very slight convexity or concavity of a plane mirror when used in oblique positions. If f_1 and f_2 coincide as closely as can be detected with the knife-edge test (*B* being free from zonal irregularities also) the reflected image of the pinhole, as seen in an eyepiece at *f*, is as exquisitely sharp and perfect as if it were formed by the spherical mirror *A* alone. But if *B* is slightly convex or concave the appearance of the eyepiece image is similar to that which has already been described in connection with astigmatic concave

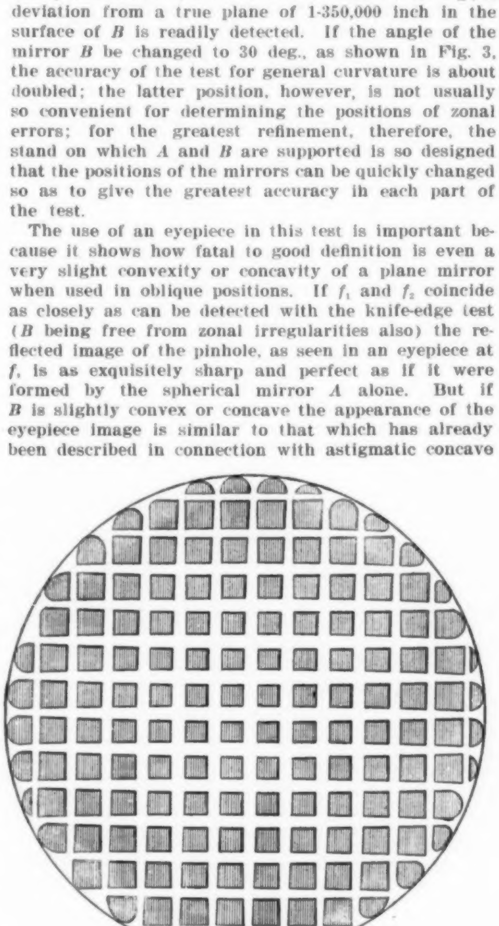


FIG. 6.—CONVEXING POLISHING TOOL FOR FIGURING PLANE MIRROR.

mirrors; the image is not sharp even at the best focus; if *B* is convex, the image becomes elongated in a vertical direction outside, and in a horizontal direction inside, of the best focus; if *B* is concave the directions of elongation are the reverse of these.

The preparation of grinding tools for plane mirrors is similar to that of tools for concave mirrors. Three full-size, flat iron tools are usually made, however, all of which are grooved. These are ground together with carborundum of finer and finer grades, until all appear flat when tested with a carefully-kept Brown & Sharpe steel straight-edge of best quality.

The plane mirror is fine-ground in the manner described for concave mirrors. It is of course a rare occurrence to find a large plane mirror nearly optically flat when it is first tested after grinding and polishing. My large mirrors almost invariably come out slightly convex when first polished; this may be due in part to the fact that the flat grinding tool becomes very slightly concave during the fine-grinding of the glass, from being worked on top. Slight convexity of the mirror at this stage of the work is much better than slight concavity, for it is much better and easier to remove a high center than a high edge, during the process of figuring with polishing tools.

Manual polishing with full-size tools should be employed when the mirror is not too large to allow this. The polishing is begun with the normal tool shown in Fig. 4, in which the grooves are of uniform width throughout. After an hour's polishing the mirror is tested; if it is found to be convex, polishing is continued with the concaving tool shown in Fig. 5, in which all of the grooves are gradually widened toward the edges of the tool, so that there is a progressive decrease of action toward the edges of the glass; the amount of this widening must be determined by experiment; it should be such that the convexity of the mirror is slowly and uniformly decreased.

If the mirror, when first tested, is found to be concave, the convexing tool shown in Fig. 6 is used to continue the polishing.

The concaving and convexing tools often tend to in-

troduce broad slight zonal errors; hence recourse must be had repeatedly to the normal tool. When all trace of general curvature has disappeared, any remaining zonal errors are eliminated by the use of the normal tool, and, if necessary, of the small local or figuring tools.

If a finished plane mirror is available which is not smaller than the one being figured, the work is very greatly facilitated by continually cold-pressing the polishing tools on the finished mirror; every precaution must be taken, however, to prevent injury to the figure of the finished mirror by such cold-pressing.

In some of the writer's early work, in which the thickness of mirrors was made only one-twelfth of their diameter, it was found that a normal polishing tool, as described above, tended to change the mirror very gradually toward a concave. This was undoubtedly due to the fact that the friction of polishing warmed the surface very slightly, thus expanding it and making it convex with reference to the polishing tool; the tool did not follow this change of form readily, hence the central parts of the glass were acted upon in excess. Furthermore, such thin mirrors, when unsilvered, were so sensitive to slight changes of temperature that the presence of the optician's body for a period of two or three minutes, at a distance of three feet from a mirror which was set up for testing, would throw a previously plane mirror convex by an amount many times greater than the smallest amount which can be detected by the knife-edge test. When the thickness of mirrors is made equal to about one-seventh of their diameter, their sensitiveness to all such temperature effects is very greatly decreased. Furthermore, in the case of silvered glass mirrors which are used for solar work, the writer has found that thick mirrors suffer very much less change of figure from exposure to the sun's heat than thin mirrors do. Silvering affords a great protection from changes of temperature, since the silver film furnishes an almost totally reflecting surface for heat radiations.

(To be continued.)

ELECTRIC IGNITERS FOR GAS ENGINES.*

By GEORGE M. HOPKINS.

GAS, gasoline, and petroleum oil engines are daily becoming more popular, and not only is the number of regular manufacturers becoming very large, but many amateurs are trying their hands at the production of engines of this class. The field is very fascinating to mechanics, but no one knows the amount of experiment required, or the vexation experienced in bringing out a motor of this class, who has not already experimented in this line.

One of the most difficult problems is that of providing an efficient means of igniting the explosive charge in the cylinder at the proper instant without intermissions or failures. A red hot tube into which the gas is admitted at the right moment is simple, good and reliable, so long as the tube lasts, but the tube speedily burns out and requires renewal. Ignition by means of a traveling flame necessitates intricate and delicate devices which require constant care to prevent failure.

The electric spark, taken all in all, is probably the best igniter, but even that has its objections. It is largely used and is simple. As many amateurs are seeking information on the subject of ignition for gas engines, we have prepared illustrations showing the principle of the electric igniter, leaving it to the engine builder to make the adaptation to the particular engine to which it is to be applied.

The essential feature of the electrical igniter is the spark coil. This does not differ from the spark coil covered magnet wire. Before winding the coil, wooden heads are secured to the ends of the core, as shown, to form a spool. The inner and outer terminals of the coil are connected with binding posts projecting from one of the heads.

The ratchet burner in connection with which the coil is intended to be used is shown in Fig. 2. The plug of the gas cock is provided with two transverse holes at right angles to each other, and the outer end of the plug carries a ratchet having eight teeth. On the shell of the gas cock is placed an angled lever carrying a spring-pressed hooked pawl, which engages the ratchet on the plug, and a spring is provided for returning the angled lever to the point of starting after it has been operated. By pulling the angled lever the plug of the cock is turned one-eighth of a revolution, so that the gas is turned on or off according to the position of the holes in the plug. To the upper end of the burner tube adjoining the tip is attached a collar which supports a wire contact near the slit of the burner. The collar is insulated from the burner by a piece of asbestos paper. The upper arm of the lever carries a spiral spring terminating in a wire contact arm which makes an electrical contact with the wire supported by the insulated collar whenever the angled lever is swung.

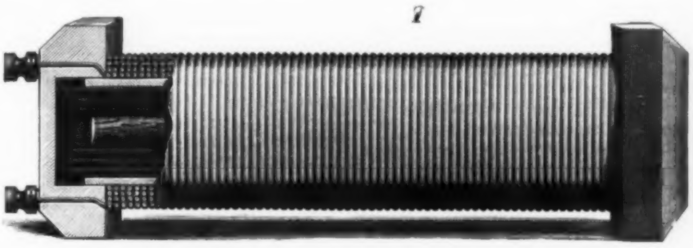


FIG. 1.—THE SPARK COIL.

It will thus be seen that by swinging the lever the passage in the burner is alternately opened and closed. The collar at the top of the burner is connected with one pole of the battery and the burner or the bracket to which it is attached is connected with one terminal of the spark coil, the other terminal of the coil being connected with the remaining pole of the battery.

When the angled lever is pulled in the manner described so as to let on the gas, the spring arm at the upper end of the lever comes into contact with the wire supported by the collar, thus completing the electrical circuit through the coil and connections, causing the core of the coil to be strongly magnetized. The further movement of the angled lever draws the spring arm off from the wire contact supported by the collar, and at the breaking of the circuit the extra or induced current generated in the coil, being of very high potential, leaps across the space between the contact wires and produces a brilliant spark which ignites the gas issuing from the burner.

When it is desired to extinguish the light the angled lever is again pulled, revolving the plug of the cock ⅛ of a revolution, cutting off the gas supply. A spark is again produced at the points of contact, but this is of no consequence.

In Figs. 3 and 4 is shown the adaptation of this principle to the ignition of the explosive mixture in a gas engine. In the passage which admits the explosive mixture to the cylinder is inserted a hollow shaft the bore of which is eccentric, and in the shaft is inserted a spindle which is insulated from the shaft and carries at its inner end a finger piece which is capable of coming into contact with a stud projecting inwardly from the casing of the engine. The finger on the spindle is held in the proper position for contact with the projecting stud by a spiral spring surrounding the spindle and connected with the hollow shaft, but insulated therefrom. The hollow shaft is provided with a spur wheel by means of which it is turned, and the spindle extending through the hollow shaft is in electrical connection with one terminal of the spark coil, the other terminal being connected with the battery, the battery in turn being connected with the engine cylinder. When the hollow shaft is rotated in the direction indicated by the arrow in Fig. 4, the finger forms a contact with the projection, and the further rotation of the hollow shaft, by virtue of the eccentric arrangement of the spindle, causes the finger to slip from the projection and thus cause a spark at the moment of separation, as in the case of the electric gas burner. This construction permits of using heavy parts which do not readily wear out or burn out.

In Fig. 5 is shown a modification, in which the igniter is operated by reciprocating movement. The sliding rod to which is attached a contact piece is carried by a sleeve having an insulating lining. When the rod is drawn back the movable contact piece slips off from the stationary contact, as indicated in dotted lines, and a spark is produced, the arrangement of the circuit being the same as in the case just described. In this case, if the charge is not to be ignited at every revolution, a commutator or switch will be connected with the rotating parts of the engine which will intermit the current as may be desired.

There are many ways in which the making and breaking of the electric circuit in the chamber containing explosive mixture may be effected. The coil might have one, two or more additional layers of magnet wire. The main difficulty with this igniter is the failing of the battery. A battery consisting of four or six Fuller cells should operate the igniter for several weeks. Leclanche cells may be used, but they should be connected up so as to produce a quantity of current rather than high voltage.

A small dynamo has been used successfully for the ignition. In this case no spark coil is required, the extra spark from the machine itself being all that is necessary.

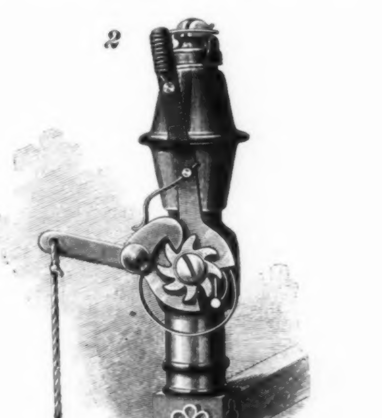
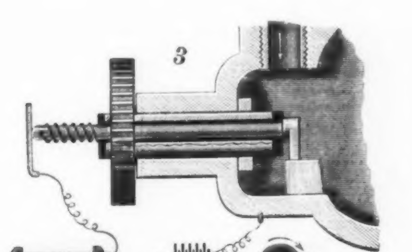


FIG. 2.—GAS BURNER WITH ELECTRIC IGNITER.



FIGS. 3 AND 4.—IGNITER FOR GAS ENGINE—REVOLVING FORM.

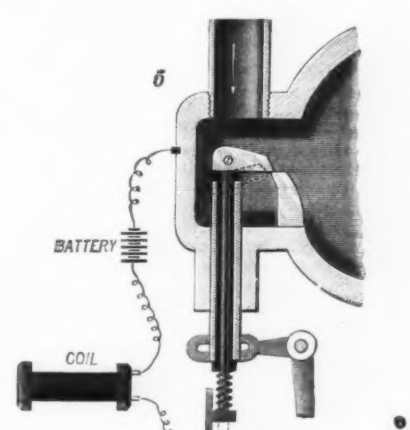


FIG. 5.—IGNITER FOR GAS ENGINE—RECIPROCATING FORM.

used in connection with an ordinary illuminating gas burner, and the electric lighting attachment to the gas burner embodies the principle of the igniter for gas engine, but it does not possess the required stability and lasting quality. The smallest practical coil is made by filling a paper mailing tube 7 inches long and 1⅝ inches in diameter with annealed iron wires of any size from No. 16 to No. 9, the wires being arranged in three or four layers around a ⅝ wooden core. Upon the paper tube are wound four layers of No. 16 cotton-

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

CALORIFIC POWER OF LIQUID FUELS.

IN a paper recently published in the Revue Technique, M. L. Levi makes the following comparison between the calorific values of different fuels used in internal combustion engines:

	B. T. U. per lb.
Methylated alcohol	10,620
Methylated alcohol mixed with 50 per cent gasoline	14,200
Crude American oil	19,630
Refined American oil	19,880

The mixture of methylated alcohol can, it is stated, be used as easily as ordinary gasoline, but unmixed with gasoline it is necessary to warm up the carbureter a little before starting, as the alcohol does not vaporize readily enough below a temperature of 68 deg. F. As an alternative gasoline may be used at the start, the alcohol being supplied later. No trouble is found with the admission valves in using alcohol, and if at times there is a deposit of soot or tar, this arises generally from the use of a bad carbureter. A little acetic acid results on combustion, but not enough to cause damage. The carbureter should be of a type which will deal out a measured quantity of the liquid at each suction stroke. The exhaust gases are free from the unpleasant smell prevalent in the case of gasoline motors. The principal objection to the use of spirit lies in cost, which, to compete with gasoline, should be about twenty cents per gallon in place of about twice as much, as is at present the case in France. In Germany the cost of methylated alcohol is only about 18 cents per gallon, so that the alcohol motor is becoming more and more popular there.—Horseless Age.

According to the Royal Mint, the coin in use in Great Britain—including that in bank reserves, as well

as that in circulation—is £124,000,000, or $620,000,000; of which £100,000,000 is gold and £24,000,000 silver. L'Economiste Française estimates the total stock of coin in France at 7,000,000,000 fr., or $1,400,000,000. In France a much higher proportion of silver is in use than in Great Britain.

SIR OLIVER LODGE ON LIGHTNING CONDUCTORS.

AN interesting lecture on "Lightning Conductors" was delivered by Sir Oliver Lodge at a recent meeting of the Birmingham Architectural Association.

Sir Oliver Lodge said that in the year 1887 his attention was especially drawn to the subject by being asked to deliver the Mann lectures, founded by Dr. Mann, an enthusiast on lightning conductors in South Africa. He perceived that the subject had not been attended to in the light of new theories and new knowledge of electricity. They were not much advanced up to 1888 beyond the times of Benjamin Franklin. During the interval electric inertia, or momentum, had been discovered, and the result of a perception of that was to enable him to say that the old views about protection from lightning were in many respects erroneous and in all respects inadequate. He proceeded to make experiments. The new views met with some opposition, but they held the field, and were universally accepted. Whether they were universally accepted or not they were undoubtedly true.

The discovery of electric inertia greatly altered ideas about lightning. The old view of lightning protection was as if it were something to be let down like rain, or as if there were a certain amount of stuff to get rid of which would take an easier path, so that if a channel were provided for it it would go down that channel and avoid all others, and that the easier path would protect all others. It was also supposed that the best way to get rid of the electricity one did not want was to supply it with the best possible conductor—the largest and best conductor one could afford; and the only reason for not using a copper rod a foot thick was the fact that it was so expensive. But a copper rod a foot thick would be dangerous; an iron wire one-tenth of an inch thick would be much safer. It had got about to a certain extent that he had said that lightning conductors were dangerous. He did not advocate the abolition of lightning conductors. It was desirable to have them, but there were certain things to be considered about them before they became as safe as they could be. He would also say that very few lightning conductors could be considered to be absolutely safe. Many protected buildings were struck and damaged. What was called protection was not complete protection, but imperfect protection was better than nothing, as a rule.

Why was it that a copper rod was not the best conductor? The answer was because of electric inertia. A copper rod let down the current too quickly, and produced a shock or collision of the utmost violence. But an iron wire allowed it to leak down, and was much safer. A copper conductor was liable to side flashes and disturbances. It used to be thought one could take hold of a conductor with the hand, and hold it while it was struck by lightning. He did not think anyone would try that experiment now. The fact was that in any building when one thing was struck a number of other things were liable to be struck simultaneously. The flash was not a single thing, but was liable to be a multiplicity of things. A small flash was quite sufficient to set things on fire; serious damage had been done by one single spark in a basement igniting the gas. A flash would often strike another building in the neighborhood, and surge underground through a pipe, or along a bell wire. If one wanted to be properly protected many conductors were better than one, but, as said, a copper conductor was not so good as an iron one. It did not damp out the oscillations; it let the current down too suddenly and was liable to side flashes. A small iron wire was ample protection so long as the wire lasted. It was true that the lightning might dissipate the wire, but by the time the flash was over the conductor had achieved its purpose. It was better to have a number of cheap conductors than one or two expensive ones. But if one wanted to be absolutely immune from lightning—and there were cases where it was desirable, such as in the case of a powder magazine, or a gun cotton factory—one could be so by providing a complete metallic inclosure like a banker's strong room. This might be struck by lightning as much as the lightning pleased, but those inside would not know anything except the noise. The only possible way to damage such a building would be for the lightning to be strong enough to melt it. The building might retain the charge, however, so that it would be as well to have sky and roof terminals.

CONTEMPORARY ELECTRICAL SCIENCE.*

RADIO-ACTIVITY OF FANGO.—Fango is a fine mud which collects about the thermal springs of Battaglia, in Lombardy. Its emanation is used for curative purposes on account of the stimulating action it appears to exert upon the circulation. F. Müller has examined it for a possible radio-activity which might account for the stimulating action observed. He first tested the fango cellar itself, and found a radio-activity considerably in excess of that ordinarily prevalent in cellars. He then sucked air through the fango, and discovered a considerable activity, which decreased with the time. The rate of decrease resembled that of radium more than any other rate, but did not completely correspond to it.—F. Müller, Physikalische Zeitschrift, July 1, 1904.

THE PONDERABLE EMISSION.—The emission discovered by Blondlot behaves like an electric convection current, and can, therefore, be deflected by electric and magnetic forces. The discoverer describes several experiments to illustrate this fact. A five-franc piece is suspended horizontally, and a sulphide screen is placed 50 centimeters below it. The luminosity of the sulphide screen is increased by the impact of the ponderable emission as it falls down through the air in a vertical line. If now a magnet is brought near that vertical line, the luminosity decreases again, although the direct effect of the magnet upon the screen, according to Gutton, is an increase of luminosity. In repeating the experiment under more rigorous conditions, the author allowed the emission to fall between the poles of two bar magnets cased in lead. The field due to the magnets was not more than 100 units. He thus obtained, not one, but three jets of emission, one traveling along the vertical as before, and the others deflected in the plane normal to the lines of force. The deflection, after a fall through 64 centimeters, amounted to about 11 centimeters for both jets. The effect is easily explained by supposing that the emission consists of a jet of mixed particles, some of which are positively and some negatively electrified, while others again are neutral. This is confirmed by the fact that one of the jets is attracted by a rubbed glass rod and the other by rubbed resin, while the central one is attracted by neither. The magnetic deflection is in a sense which accords with the above explanation. The author also announces that a slight irregularity of the path of the jets was found to be due to currents of air. This means that the air is capable of conveying the emission. Hence, also, the emission can exert a drag upon the air, and, therefore, experiences a frictional resistance in passing through it. This accounts for the fact, already specified, that the parabola described by a jet projected horizontally is not perfect, but has a vertical asymptote, like the path of a projectile shot horizontally in a resisting medium.—R. Blondlot, Comptes Rendus, June 27, 1904.

OCCURRENCE OF RADIO-ACTIVE MATTER.—After discovering the presence of a radio-active gas in the Cambridge tap water, J. J. Thomson has made further experiments, and has found that a radio-active substance, apparently radium, is exceedingly widely distributed, and occurs in the most unexpected places. The following substances gave most unmistakable evidence of containing a radio-active emanation: Soil from the garden adjoining the Cavendish laboratory, Cambridge gault, gravel from a pit at Chesterton, powdered bricks, powdered glass, sea sand from the beach at Whitby (this was exceedingly rich in the emanation), blue lias from Whitby. One specimen of powdered silica contained a very large quantity of the emanation, other specimens little or none. One specimen of wheaten flour contained an appreciable amount of emanation, other specimens none. Practically all the clays, sands, and gravels tested gave off the emanation. The latter, to judge from its rate of decay, seems to be the same as that given off by radium. The capriciousness of the emanation tells against its being a universal property of all matter, but the author believes that most, if not all, bodies are continually emitting a radiation which, like the Röntgen rays, can ionize a gas through which it is passed. The radiation streaming through bodies will not be all of one type, the primary will give rise to secondary, and that again to tertiary, and it is probable that in small vessels part of the ionization in the vessel is due to the secondary and tertiary radiation proceeding from its walls. The radiation absorbed by the air is not wholly used in producing radiation of the same kind, since part of it is spent in ionizing the gas, and is, on the recombination of the ions, converted into heat. The mechanical equivalent of the heat developed by the recombination of the ions in a cubic centimeter of air at atmospheric pressure and temperature is between 1 and 10 ergs per century, and this will be a measure of the amount of internal atomic energy lost by a cubic centimeter of air in the same time.—J. J. Thomson, Proceedings of the Cambridge Philosophical Society, April 22, 1904.

ANÆSTHESIA OF METALS.—Since the researches of Jagadis Chunder Bose it is known that certain poisons, and especially anæsthetics, diminish the "electric response of matter," or the return to equilibrium after an excitation, either because they increase the viscosity or diminish the elasticity of the material. If that is so, it is intelligible that the matter affected should be unable to follow the extremely rapid vibrations which give rise to N-rays. J. Becquerel has therefore examined the action of anæsthetics in diminishing the transmission of N-rays and the response to their impact. He used a hollow cone of aluminium or copper,* and placed the source of N-rays under its base. The sensitive screen was placed at the apex, and the whole inclosed in a vessel which could be filled with air or with the vapor of chloroform or other anæsthetic. It was then found that if the base was protected against the immediate action of the chloroform by means of a plate of thin glass, the rays passed in spite of the presence of the vapor if the source was inclosed in a box of glass, wood or cardboard; but all action ceased if the box was made of aluminium or copper. The author concludes that aluminium and copper lose their transparency for N-rays when the surface which receives the radiation (in this case the base of the cone) or the surface from which the rays proceed (in this case the box containing the source) is exposed to the action of an anæsthetic. Glass, wood, and cardboard, on the other hand, always allow the radiation to pass. The author is inclined to believe that the N-rays consist of two different radiations, one of them traversing glass and other substances with the velocity of light, or nearly so, as shown by the index of refraction, and a form of energy which is only propagated slowly and which stops at the surface of chloroformed metals.—J. Becquerel, Comptes Rendus, June 6, 1904.

* Compiled by E. E. Fournier d'Albe in the Electrician.

AMBULANCE DOGS IN WARFARE.

SOME interesting experiments were tried upon Wimbledon Common recently with dogs trained by Major Hautdeville Richardson for ambulance purposes. The idea of using dogs for this purpose takes its origin from the dogs trained by the monks of St. Bernard for finding bodies lost in the snow. The St. Bernard breed of dog is, however, too large and not swift enough for use in war and the same remark applies to bloodhounds. These dogs, moreover, hunt by smell, whereas the sheep-dog or collie is said to hunt by intelligence or with its brains and not by smell, the crossbred dog showing even greater intelligence in this respect than the thoroughbred. The use of dogs for war purposes has been tried by the German army, and some 200 dogs formed part of the Herero expedition. Major Richardson has sent some trained dogs to Russia for use in the present war and these are said to have given satisfaction, and Italy, Austria, and Switzerland are also trying the experiment which may be said to be still *sub judice*. The experiments which took place recently were intended to demonstrate the use of dogs in locating the wounded in the open and under cover, neither of which they did unassisted, and in carrying succor to the wounded when found in the shape of bandages and brandy. For the purpose of the experiment only two dogs were employed, the one a cross between a collie and an Esquimau and the other a cross between a retriever and a collie, the former being if anything the better of the two at its work. Each dog was provided with a waterproof canvas saddle with the Red Cross painted upon each side, which contained eight bandages for the wounded, a wooden barrel of brandy was suspended below the neck, a small water-proof sheet was attached to the neck of the animal as was a bell for night use. With regard to the experiments their success on Wimbledon Common was only partial. Many of the "wounded" lying in the open were plainly visible to the onlookers and yet the dogs, after being released from the leash with the order, "Seek wounded," went gaily barking past the wounded in their glad release, while in finding persons located under cover they had to be assisted by Major Richardson. The verdict of those present at these experiments was that the result was anything but conclusive. It must in justice to Major Richardson and his dogs be said that they had traveled over night from Scotland and might naturally be tired and not so keen as otherwise they might have been; but the question naturally arises, What practical value to ambulance work will dogs be even if the system is properly and more efficiently developed? That dogs with the aid of hospital orderlies would be of assistance in locating stricken people on distant parts of a battlefield is perfectly true, but that a dog unaccompanied would discriminate between one actually dead and those in need of relief is quite another thing. Again, those in need of relief are generally beyond the power of helping themselves to the relief which the dog might bring them, and to those who are not injured so seriously as to be unable to help themselves the bandages would be of no more use than those already supplied in the antiseptic first aid dressing to be found sewn in the skirt of every soldier's tunic when proceeding to the front. This, as we know, in South Africa largely helped to the keeping clean and quick healing of wounds by its immediate application by the wounded soldier himself. The brandy carried by the ambulance dog would certainly be at the disposal of the wounded, but it is questionable whether it would be beneficial to him or not, especially if his wound was attended with hemorrhage. As water carriers or as bearers of ammunition dogs might certainly prove of use. Dogs, as is very well known, will attach themselves to regiments and would undoubtedly either by instinct or smell go to men belonging to that regiment and thus carry them assistance. Whether they recognize uniform or are guided by smell or intelligence, or both, it is impossible to say. Smell has probably most to do with the power of a dog to locate the wounded. The giant of story said—

"I smell the blood of an Englishman,
Be he alive or be he dead"—

but we are not told that he could further decide whether our countryman was still with us or was gone before. The ambulance dog would be in the same plight. The power of discriminating between the live and the dead would be impossible and the ambulance dog is quite as likely to remain by the side of the dead man as by the side of the living. By the smell of blood is not meant the smell of actual blood, for in the case of a wounded man this might or might not be present. But the smell of an Englishman is probably as perfectly clear to a dog's keen sense of smell as the smell of a Kaffir is equally distinct to us. It is very probable that the benefit to be derived from ambulance dogs in

warfare is not worth the expense of $125 per dog which is said to be the commercial value of one of these trained dogs, and we think that the British War Office for the present is quite right in awaiting further evidence of their usefulness.—Lancet.

ENGINEERING NOTES.

One of the interesting applications of concrete, says Machinery, is that of using it for setting posts and similar work, which, if set in the ground unprotected, would soon rot away. A wooden post treated with tar and set in a hole on a flat stone and surrounded by a firmly tamped bed of concrete is practically indestructible and will furnish a sound, substantial foundation for years to come. The same plan is used to some extent in setting of trolley poles, especially when made of iron. The small diameter of the pole does not give the necessary stability to prevent its being racked out of place by the surging of the trolley wire. But if an ordinary hole dug for such a pole is filled with concrete it forms a mass 25 or 30 inches in diameter and of a length equal to the depth of the hole, which is solidly united to the pole, giving the latter several times the stability that it would have if set in earth alone. Moreover, the concrete preserves the iron for practically all time against corrosion, and it might reasonably be expected that poles so set may rust away above ground before the portion protected by concrete is appreciably affected.

A joint convention has been signed by the French and Spanish governments for the construction of three new railroads across the Pyrenees mountain chain, some 270 miles in width and separating the two countries. At the present time there are only two railroads crossing this frontier, affording through direct communication between the two countries. One, the northern route, connects the French towns of Bordeaux and Bayonne with San Sebastian and Madrid, while the southern route runs from Narbonne on the Gulf of Lyons through Port Vendres and Geroux to the port of Barcelona. These railroads have long been considered insufficient for the exigencies of the traffic between the two countries. According to the new project communication will be established from three points on the French side, Aix-les-Thermes, Oloron, and Saint Gerous, with the following corresponding Spanish towns on the opposite side of the Pyrenees—Rippol, Quera, and Lerida respectively. The construction of the railroad between Aix and Rippol will considerably decrease the distance between Toulouse and Barcelona, as it is much more direct than the long and tortuous detour through Narbonne, Perpignan, and Gerone being avoided. By the completion of the railroad from Oloron to Quera, direct connection is established between Saragossa and Bordeaux, thereby shortening the journey from Paris to Madrid to a very appreciable degree. The third railroad, between Saint Gerous and Lerida, opens a new route in the western portion of the frontier. The three railroads, according to the terms of the treaty, are to be completed and opened for traffic within ten years, but there is every probability that the work will be finished in much less time.

The value of a thorough education fitting a young man for his life-work is no longer a debatable question. The recent report of the United States Bureau of Education shows that a boy with a common-school education has practically one chance in 9,000 of general recognition as a successful man in some department of human endeavor and usefulness. A high-school education increases his chances of such success by about twenty-two times, while a college education gives a young man about ten times the probability of success and advancement possessed by the high-school graduate, or about two hundred times the opportunity open to the boy with only a common-school education. While the basis of income which a man may be able to secure is, in many respects, a false standard of comparison, yet it is perhaps as definite a measure of his worth as any single method at our command. For this reason, the following data presented by Mr. Dodge in his recent presidential address before the American Society of Mechanical Engineers are of much interest. From carefully prepared averages he found that in engineering work the average unskilled man at twenty-two years of age has reached his maximum earning capacity of $510 per year, which, capitalized at five per cent, gives him a potential value of about $10,000. The shop-trained man reaches his maximum of $790 per year at twenty-four years of age, while the curve of income for the technical school graduate of ten years' standing is still rising at thirty-two years of age, when he receives an annual income of $2,150, which gives him a potential value of $43,000 when capitalized at five per cent. Although this result, as shown by Mr. Dodge, has been criticised as being more favorable to the technical graduate than is justified in the average case, a diagram, which has recently been prepared from data received from graduates of the Worcester Polytechnic Institute in Electrical Engineering, substantiates the conclusions drawn by him and further emphasizes the value of a thorough technical training such as that given by the Worcester Polytechnic Institute. This diagram is probably unique in that it shows most completely the financial prospects of technical graduates from year to year. As the Department of Electrical Engineering at the Worcester Polytechnic Institute has been established but eight years, there are data available for this period only, but during this time a large number of students have graduated, and data have been received from a sufficient number of them to represent conditions fairly. From these curves, it is seen that the average graduate who receives $500 per year for his first position after leaving the Institute rapidly increases in value, so that, at the end of eight years, he may expect to receive an income of about $1,900; or, if he has been a graduate student at the Institute for one year, his income is shown to average about $2,500, which, capitalized at five per cent, gives him the income on an investment of about $50,000. By investing five years of his time and the cost of his college training, he has after a few years and for the remainder of his life increased his income earning value by not less than $40,000.

ELECTRICAL NOTES.

Telephonic communication in Abyssinia is being rapidly developed. There are already 800 miles of line in operation, and 1,000 miles more have been projected. The work is being carried out by the Italian Ministry of Posts, and is beset with innumerable difficulties. In some districts the posts have to be continually re-erected because, through torrential rains turning the land into soft bog, they have fallen down. In drier districts wooden posts are devoured by insects, and when they are replaced by others of iron, they are carried off by the population to be converted into agricultural or domestic implements. To circumvent these thieving propensities of the inhabitants, the telephone lines have to be constantly patroled by special police.

One of the most important electric installations, both for motive and lighting purposes, in connection with cotton mills is to be carried out in Spain. The Marquess of Larios, who has been responsible for pioneering many Spanish industries, possesses the largest weaving and spinning mills in the country, giving employment to some 5,000 hands. These manufactories, together with dyeing and hosiery works, are situated at Malaga in Andalusia. The extensive steam plant for generating the requisite power for these mills is to be entirely superseded by electricity. The three-phase current is to be drawn from the Chorro Power Company, which has established and equipped a generating station at the well-known Chorro Gorge, some 50 miles north of Malaga. The current is transmitted to the latter point at a pressure of 25,000 volts. At Malaga there is a sub-station, where the potential is reduced to 2,500 volts, part of the current being consumed by the electric lighting station of the town. The current will be transmitted from this sub-station to the mills through underground cables for a distance of about half a mile. Secondary receiving stations are to be installed at each mill to reduce the pressure from 2,500 volts to 400 volts, at which potential it will be supplied to the three-phase motors. The plant comprises seventy-two motors varying in power from 3 horse-power to 150 horse-power, and representing an aggregate of 2,500 horse-power. By this supercession of steam by electricity, it is anticipated that the annual cost of providing power will be reduced by more than 20 per cent.

The railroad which runs from Alexandria to Ramleh, which formerly ran by steam locomotives, has recently adopted electric traction. This road is one of the oldest lines in Egypt, and some of the locomotives it used in 1866 are still to be found running on other lines in the region. It is the second railroad of the country to be transformed to electric traction. The road has a considerable passenger traffic between Alexandria and Ramleh running along the Mediterranean coast. The use of electric traction commenced in March, 1903, and at the end of last December the figures show an increase of 33 per cent, and the traffic is still on the increase. Current is supplied from a central station at Karmous, at some distance from the road. Three-phase current at high tension is delivered from the main plant to two sub-stations which supply the road. The main station contains ten boilers using bituminous coal, and two horizontal engines of 800 horse-power supplied by an Italian firm. The engines are coupled to three-phase alternators of 600 kilowatts. These machines have a revolving field and deliver 6,500 volts to the main line. This current is lowered in the two sub-stations to 500 volts for the trolley. The Bulkeley sub-station, which is the larger, contains three rotary converters of 300 kilowatts to this effect, and nine transformers of 125 kilowatts. The rolling stock consists of fifty cars of the latest European type, with double deck. The first car of the train carries the motors, while the second is a trailer. The motors have a capacity of 35 horse-power each, and run at 30 miles an hour.

In a paper recently presented to the Académie des Sciences, M. Balland brings out some points relating to a new process of whitening flour by electricity. In order to satisfy the demands of consumers for an increased whiteness of bread, we observe an extraordinary evolution in the methods of bolting by cylinders and we find, to the detriment of the general alimentation, that the yield of wheat in the shape of flour has fallen gradually in less than 35 years from 76, 65, 60 and in recent years to 55 per cent. Now, the process of whitening is carried still further and an electric method has been successfully employed in France for this purpose. The author received two samples of flour from M. Charles Lucas, president of the Paris Flour Exchange, one being obtained by the usual process and the other the same flour after having undergone a treatment by contact with electrified air. At first sight the electrically-treated flour is certainly whiter in color, but its odor and taste are less agreeable. Analysis gave the following percentages, with the figures for the electrically-treated flour in parenthesis: Water, ordinary flour, 11.40 per cent; treated flour, 11.45 per cent; nitrogeneous matter, 9.86 (9.91); fatty matter, 0.92 (0.98); cellulose, 0.10 (0.10); ash, 0.50 (0.49); acidity, 0.0147 (0.0196). The phosphated products are represented in each case by 0.17 per cent of phosphoric acid. The modifications bear mainly on the fatty matter and the acidity. The fatty matter of the flour, after the electrical treatment, is slightly rancid; it is less fluid and less colored. The yellow oil of wheat which is so aromatic at the time of bolting, has been oxidized and partly transformed to white fatty acids, soluble in absolute alcohol. The wet gluten does not show an appreciable difference in weight, color or extensibility, but its odor is less delicate. The dry gluten has a lighter color. Bread made from the bleached flour is whiter but not so savory.

SCIENCE NOTES.

In pursuing his researches upon different kinds of steels, L. Guillet, of Paris, observed specially the action of titanium and tin. At present titanium plays but an unimportant rôle in metallurgy; at most it acts as a purifier of the metal, seeing that it combines with the oxygen and nitrogen. The experimenter observes that up to a value of 10 per cent, titanium has no influence upon the micro-structure of the steels. It has but a slight action upon the mechanical properties of samples having a greater or less percentage of carbon. It does not seem to increase the breaking strain and the elastic limit, nor to diminish the elongation or stricture. He considers that titanium steel is not called upon to play any great part in the industry. As to the combinations of tin, he finds that this metal enters into solution in the iron, but when the value exceeds 5 per cent, it seems to form a combination with the latter. Tin has no influence upon the perlite. It gives the metal an extreme hardness and brittleness. In this case all the carbon is in the state of carbide.

Eastern Asia is one of the regions of the globe which is abundantly supplied with combustible minerals in the shape of coal and oil. While the area of the coal and petroleum regions of Europe only represents a total of 24,000 square miles, that of eastern Asia is incomparably greater. Besides, the region possesses subterranean reservoirs of oil which in the future will no doubt prove a base for great industrial enterprises. Oil is found nearly everywhere in the region, in China, in Manchuria, in Japan, and especially in the island of Sakhalm, which lies in the bay of the Amour river. It is claimed that the oil region near the river Noosteva, one of the largest streams of the island, exceeds the Baku region of Southern Russia in importance. Here are to be found no less than seven underground reservoirs of oil, one of which has a surface of over 60,000 square yards. It is not astonishing, therefore, that Japan wished to obtain possession of Sakhalm Island for a long time past. Although Japan produced over 200,000 tons of oil in 1900 it was obliged to import nearly an equal quantity during that year. On the other hand, Russia will naturally endeavor to keep possession of this valuable region, and besides, the island will prove to be an important point as regards the navigation of the Amour river and Siberian commerce in general.

The influence of low temperatures upon color is brought out by Jules Schmidlin in a paper read before the Paris Academy of Sciences. Numerous cases are observed where certain bodies change color with the temperature. For instance, oxide of zinc and other substances, when heated, take a darker tint, and again some bodies lose their color at low temperatures. Owing to the latter fact, a hypothesis has been maintained that at the absolute zero of temperature all bodies would be white. Therefore it is of interest to observe the action of the low temperature obtained by liquid air upon coloring matter of different kinds. In the solid state or fixed upon a textile fiber such as silk or wool the color does not appear to change to any great degree. But it is otherwise in solutions of coloring matter. In solidifying by the extreme cold, the alcohol containing the coloring matter forms solid solutions and the effect of the temperature upon the color is easily observed. Many of the coloring matters do not change color in the alcohol solution, such as methylene blue and malachite green, but others, especially some of the rosanilines, show a marked change. When a tube containing an alcoholic solution of chlorhydrate of rosaniline is plunged into liquid air we see that the red color diminishes considerably in intensity and at the same time a fine fluorescence of a yellow-green color is noted. The solution now takes the appearance of an eosine solution. The salts of hexamethyl-rosaniline show a similar action, and the violet color falls off, while a brown fluorescence is observed. In the case of eosine solutions the intensity of the red color seen by transparence diminishes at the low temperature, while the color of the fluorescence remains constant. The fact that the color due to fluorescence acts differently from the ordinary color is in accord with the theory that the former is produced in a different manner. Supposing that fluorescence consists in a transformation of the short waves into longer ones, the ordinary color is the result of the absorption of the complimentary rays, which consists in transforming the movement of the waves into an irregular movement of ponderable molecules or, in fact, into heat.

TRADE NOTES AND RECIPES.

Production of Bath Metal.—This alloy is used especially in England for the manufacture of teapots, and is very popular owing to the fine white color it possesses. It takes a high degree of polish, and articles made from this alloy acquire in the course of time, upon only being rubbed with a white cloth, a permanent silvery luster. The composition of Bath metal is copper 55 parts, zinc 45 parts.—Der Metallarbeiter.

Production of Fast Stamping Color.—Rub up separately, 20 parts of cupric sulphate and 20 parts of anilic hydrochlorate, then mix carefully together, after adding 10 parts of dextrin. The mixture is next ground with 5 parts of glycerine and sufficient water until a thick, uniform, paste-like mass results, adapted for use by means of stencil and bristle-brush. Aniline black is formed thereby in and upön the fiber, which is not destroyed by boiling.—Pharmaceutische Zeitung.

Reproduction of Faded Pictures.—Make two successive negatives of the original picture without moving the camera so that both negatives will register perfectly. For one use normal exposure, for the other under-exposure, for example, 5 and 3 seconds respectively. Develop as usual and retouch on the normally-exposed negative. Now lay the under-exposed negative with the layer on the glass side of the normal one, so that both pictures register, and paste the edges together with gummed paper. Then print in diffused light. The lowermost weak negative is strengthened by the upper too hard one to such an extent that frequently pictures with very good contrasts result. The two coatings being separated by a glass plate, the upper vignetting one prints soft and gives the tones, while the lower one reproduces the outlines sharply.—Neueste Erfindungen und Erfahrungen.

Production of Gelatine-Zinc Glue.—The Pharmaceutische Zeitung, of Berlin, gives the following direction for its preparation:

1. White zinc oxide	20.0
Pure glycerine	80.0
White gelatine	20.0
Distilled water	80.0

Rub up the zinc oxide and glycerine finely and add the gelatine solution, hot.

2. The best receipt for soft zinc glue reads:	
Distilled water	55.0
Gelatine	12.5
Glycerine	12.5
Zinc oxide	20.0

This glue melts at 37.75 deg. C., solidifies at 28 deg. C., and possesses a contractility of 16 millimeters for a stick 10 centimeters long, inside of five days.

For hard zinc glue the following receipt is recommended:

Distilled water	50.0
Gelatine	15.0
Glycerine	10.0
Zinc oxide	25.0

This glue melts at 38.75 deg. C. and solidifies at 31 deg. C. Contractility, 22 millimeters for a stick 10 centimeters in length.

Recipes for Cements, Glues, Etc.—Glass Cement: In a glass flask having a rising tube dissolve 10 parts of caoutchouc and 110 parts of mastic in 300 parts of chloroform.

Cement for Stones: Slaked lime 10 parts, chalk 15 parts, kaolin 5 parts; mix, and immediately before use stir with a corresponding amount of potash water-glass.

Liquid Porcelain Cement: Fish glue 20 parts, glacial acetic acid 20 parts; heat together until the mass gelatinizes on cooling.

New Photographic Paste: In a solution of acetic acid 1 part, in water 2 parts, dissolve dextrin 2 parts, and add with stirring alcohol 1 part.

Glass Cement: Dissolve in 150 parts of acetic acid of 96 per cent, 100 parts of gelatine by the use of heat, and add ammonium bichromate 5 parts. This glue must be preserved away from the light.

Adhesive Mucilage: To 250 parts of gum arabic mucilage add 20 parts of water and 2 parts of sulphate of alumina and heat until dissolved.

New Glue, Very Economical: Dissolve bone glue 250 parts by heating in 1,000 parts of water, and add to the solution barium peroxide 10 parts, sulphuric acid (66 deg. B.) 5 parts, and water 15 parts. Heat for 48 hours on the water-bath to 80 deg. C. Thus a syrupy liquid is obtained, which is allowed to settle and then decanted. This glue has no unpleasant odor, and does not mold.

Cement for Porcelain on Metal: Mix finely-powdered burned lime 300 parts with powdered starch 250 parts, and moisten the mixture with a compound of equal parts of water and alcohol of 95 per cent until a paste results.

Bookbinder's Paste: Dissolve 20 parts of alum in 1,000 parts of water with the aid of heat, and upon cooling add enough flour to produce a cream-like consistency. Then heat with constant stirring. To enhance the keeping qualities, add a few drops of clove oil. This paste may also be obtained in solid form by adding to the alum solution mixed with the flour, before the heating, a little powdered rosin and one or two cloves. This solid paste keeps several months. For use it should be softened with a little water.

Diamond Glass Cement: Dissolve 100 parts of fish glue in 150 parts of 90 per cent alcohol and add, with constant stirring, 200 parts of powdered rosin. This cement must be preserved in absolutely tight-closing bottles, as it solidifies very quickly.—Off. Chim., Paris, through Seifensieder Zeitung.

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